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TRANSMITTAL FORM

(to be used for all correspondence after initial filing)

Application Number	09/317,124
Filing Date	May 24, 1999
First Named Inventor	Hinton
Group Art Unit	2132
Examiner Name	Zand
Attorney Docket Number	000479.77772

Total Number of Pages in This Submission

ENCLOSURES *(check all that apply)*

- [x] Fee Transmittal Form
  - [ ] Fee Attached
- [ ] Amendment / Response
  - [ ] After Final
  - [ ] Affidavits/declaration(s)
- [ ] Extension of Time Request
- [ ] Express Abandonment Request
- [ ] Information Disclosure Statement
- [ ] Certified Copy of Priority Document(s)
- [ ] Response to Missing Parts/ Incomplete Application
  - [ ] Response to Missing Parts under 37 CFR 1.52 or 1.53
- [ ] Assignment Papers *(for an Application)*
- [ ] Drawing(s)
- [ ] Licensing-related Papers
- [ ] Petition
- [ ] Petition to Convert to a Provisional Application
- [ ] Power of Attorney, Revocation Change of Correspondence Address
- [ ] Terminal Disclaimer
- [ ] Request for Refund
- [ ] CD, Number of CD(s) _____
- [ ] After Allowance Communication to Group
- [ ] Appeal Communication to Board of Appeals and Interferences
- [x] Appeal Communication to Group *(Appeal Notice, Brief, Reply Brief)*
- [ ] Proprietary Information
- [ ] Status Letter
- [x] Other Enclosure(s) *(please identify below)*:

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Remarks

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Express Mail No. EV 306401402 US

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm *or* Individual name	Kenneth F. Smolik Banner & Witcoff, Ltd.
Signature	Kenneth F Smolik
Date	August 2, 2004

CERTIFICATE OF EXPRESS MAIL
(PATENT)

Attorney Docket No. 000479.77772

Express Mail No. EV 306401402 US
Deposited August 2, 2004

I hereby certify that the attached correspondence, identified below, is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" under 37 CFR §1.10 on the date indicated above and is addressed to MS: Appeal Brief-Patents, Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

By:____________________

Hinton, U.S. Patent Application No. 09/317,124 for "CHAOTIC COMMUNICATION SYSTEM AND METHOD USING MODULATION OF NONREACTIVE CIRCUIT ELEMENTS"

- Transmittal Form (in duplicate)
- Fee Transmittal (in duplicate)
- Brief on Appeal (83 pages/in triplicate)
- Return Receipt Postcard

BANNER & WITCOFF, LTD.
10 South Wacker Drive
Chicago, Illinois 60606
Telephone: 312-463-5000

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FEE TRANSMITTAL for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 330

Complete If Known	
Application Number	09/317,124
Filing Date	May 24, 1999
First Named Inventor	Hinton
Examiner Name	Zand
Art Unit	2132
Attorney Docket No.	00479.77772

METHOD OF PAYMENT (*check all that apply*)

☐ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account:

Deposit Account Number: 19-0733

Deposit Account Name: Banner & Witcoff, LTD.

The Director is authorized to: (*check all that apply*)

☒ Charge fee(s) indicated below ☒ Credit any overpayments
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to the above-identified deposit account.

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	

SUBTOTAL (1) ($) 0

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee from below		Fee Paid
Total Claims	-	** =	0	X		=	0
Independent Claims	-	** =	0	X		=	0
Multiple Dependent	0			X		=	0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0

**or number previously paid, if greater; For Reissues, see above

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet.	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	330
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive – unavoidable	
1453	1,330	2453	665	Petition to revive – unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17 (q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 330

SUBMITTED BY				Complete (*if applicable*)	
Name (Print/Type)	Kenneth F. Smolik	Registration No. (Attorney/Agent)	44,344	Telephone	312-463-5000
Signature	Kenneth F. Smolik			Date	August 2, 2004

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No. 000479.77772

In re U.S. Patent Application of Hinton, et al.	)	
	)	Group Art Unit: 2132
Application No. 09/317,124	)	
	)	Examiner: Zand, Kambiz
Filed: May 24, 1999	)	
	)	Confirmation No. 8668
For: Chaotic Communication System and Method Using Modulation or Nonreactive Circuit Elements	)	

BRIEF ON APPEAL

Mail Stop: Appeal Brief-Patents
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is an Appeal Brief in accordance with 37 CFR §1.192, filed in triplicate in support of applicant's June 2, 2004 Notice of Appeal. Appeal is taken from the Final Office Action mailed March 22, 2004. Please charge any necessary fees in connection with this Appeal Brief to our Deposit Account No. 19-0733.

REAL PARTY IN INTEREST

The owner of this application, and the real party in interest, is Science Applications International Corporation.

RELATED APPEALS AND INTERFERENCES

There are no related appeals and interferences.

STATUS OF CLAIMS

Claims 1-159 are rejected. All of the pending claims (1-159) are shown in the attached appendix.

Claims 36-44, 54-109, and 111-159 stand rejected under 35 USC 112, first paragraph, as failing to comply with the enablement requirement. Claims 36-44, 54-109, and 111-159 stand rejected under 35 USC 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. Claims 1-159 are rejected under 102(b) as being anticipated by Pinkney ("Chaos Shift Keying Communications System Using Self-Synchronization Chua Oscillators," Electronic Letters, Vol. 31, No. 13, June 22, 1995, pages 1021-1022). Claims 1-159 stand rejected under 35 USC 102(b) as being anticipated by Chua ("Secure Communication via Chaotic Parameter Modulation," IEEE Transactions on Circuits and Systems, Vol. 43, No. 9, September 1996, pages 817-819). Claims 1-159 stand rejected under 35 USC 102(b) as being anticipated by Cuomo (U.S. Patent No. 5,291,555). Claims 1-159 stand rejected under 35 USC 102(e) as being anticipated by Tresser (U.S. Patent No. 6,064,701). Claims 1-159 stand rejected under 35 USC 103(a) "as being unpatentable over Applicant's Admission of Prior Art."

Appellant hereby appeals the rejections of claims 1-159.

STATUS OF AMENDMENTS

No amendments have been filed.

SUMMARY OF INVENTION

In making reference herein to various portions of the specification and drawings in order to explain the claimed invention (as required by 37 CFR §1.192(c)(5)), Appellant does not intend to limit the claims; all references to the specification and drawings are illustrative unless otherwise explicitly stated.

An aspect of the invention provides a method for transmitting information by generating a chaotic carrier signal, in which a corresponding voltage oscillates chaotically about a first

equilibrium point in current-voltage phase space and by changing a non-reactive resistive value in the circuit in response to an information signal (e.g., Figure 19D; page 38, lines 12-22).

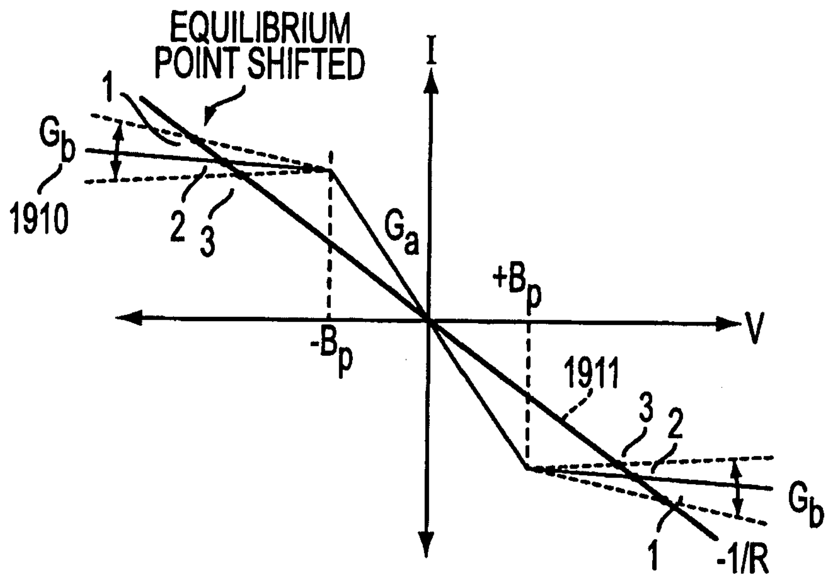

FIG. 19D

Correspondingly, an equilibrium point can be shifted along a load line (shown as load line 1911).

Another aspect of the invention provides a chaotic transmitting circuit in which an oscillator circuit is coupled to a chaotic circuit through a resistor. Switch 736 changes a nonreactive value in the chaotic circuit in accordance with an information signal (e.g., Figure 7A; page 42, line 22 to page 43, line 6).

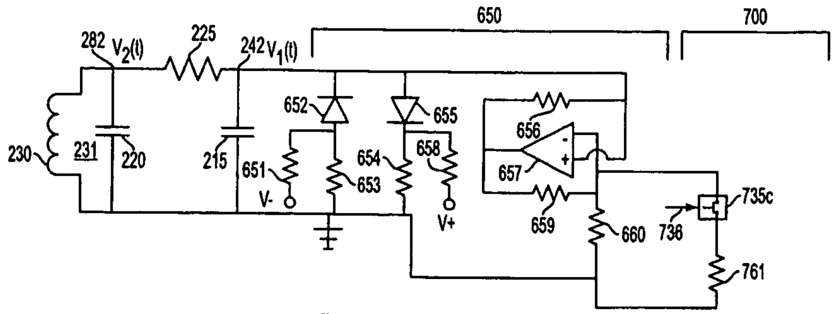

FIG. 7A

Another aspect of the invention provides a nonlinear circuit element in a chaotic transmitter, in which the nonlinear circuit element comprises two pairs of diodes (681,682 and 683,684) (Figure 6C; page 42, lines 14-21).

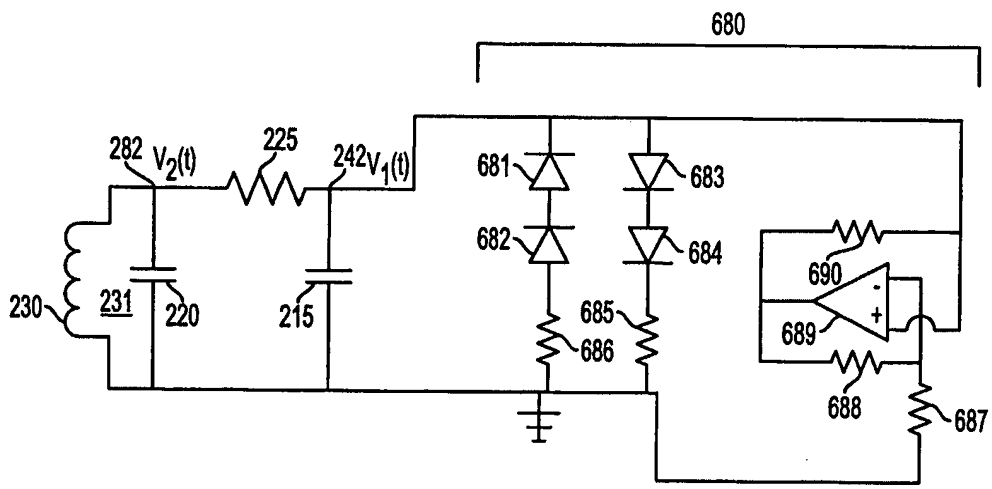

FIG. 6C

One pair of diodes is forward biased and the other pair is reversed biased with respect to the circuit terminals. An operational amplifier is connected between the circuit terminals.

Another aspect of the invention provides an oscillator circuit that is coupled to a chaotic circuit that exhibits a current-voltage characteristic shape (page 37, line 26 to page 38, line 11; Figures 19A and 19B).

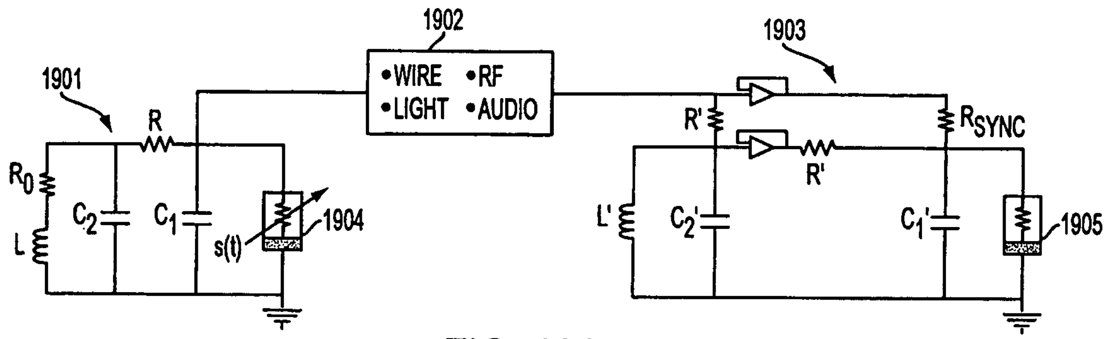

FIG. 19A

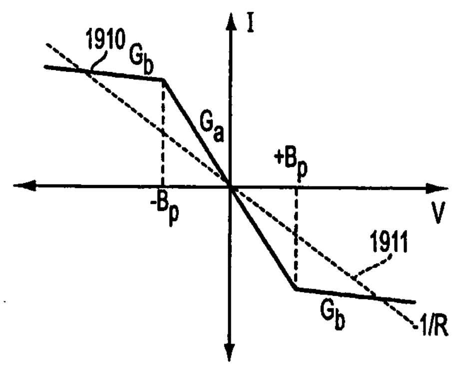

FIG. 19B

A switch that is coupled to the chaotic circuit changes a nonreactive resistive value in the chaotic circuit in accordance with an information signal. With a variation, the chaotic circuit includes a diode circuit that exhibits a negative piecewise linear resistance (Figure 19B).

Another aspect of the invention provides a chaotic transmitter (Figure 13; page 59, lines 5-17) with a resistor coupled to the oscillator (corresponding to resistor 225), a chaotic circuit comprising a negative resistance, wherein the chaotic circuit is coupled to the oscillator circuit through the resistor (corresponding to resistor 284), an isolation amplifier coupled to the oscillator (corresponding to amplifier 1308), a filter coupled to the output of the isolation amplifier that limits a frequency bandwidth present at the chaotic circuit (corresponding to filter 1309), and a means for modulating a circuit element of the chaotic transmitter in accordance with an information signal (Figure 19D as previously shown and Figure 19E).

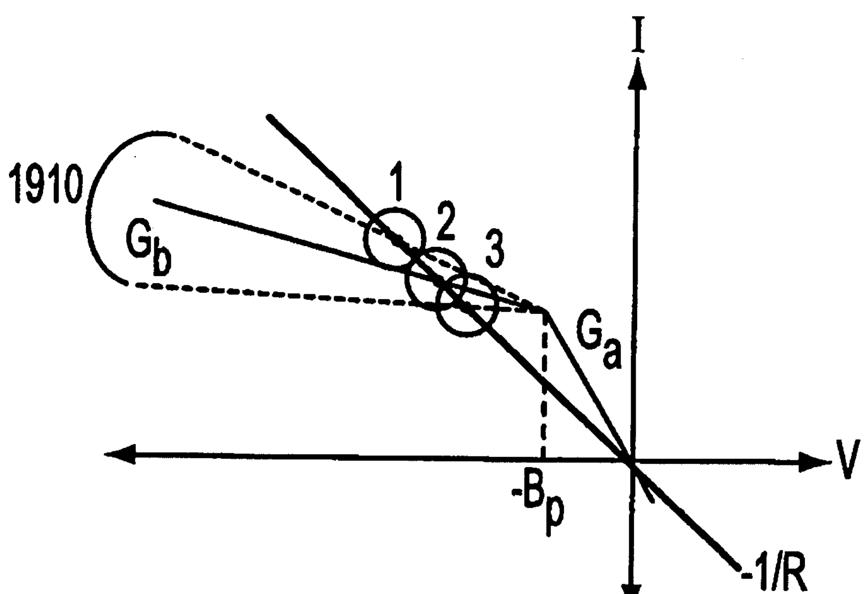

FIG. 19E

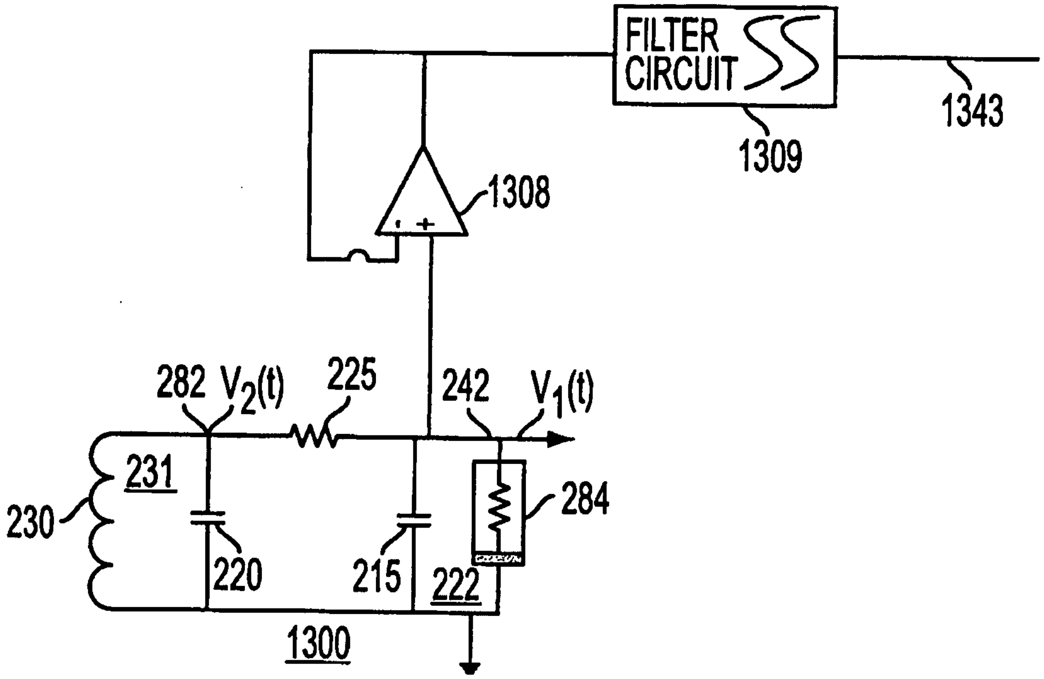

FIG. 13

Another aspect of the invention supports a transmitting system (Figure 38; page 75, line 28 to page 77, line 26) with a plurality of 2^N transmitters, in which each transmitter generates a chaotic strange attractor signal that is distinct from the other transmitters (corresponding to transmitters 4020-4050), a switch (in response to receiving a time-varying N-bit code representing a unit of information) that selects a corresponding one of the plurality of 2^N transmitters (corresponding to switch 4060), and a transmission circuit that transmits the selected chaotic strange attractor signal across a transmission channel (corresponding to circuit 4070).

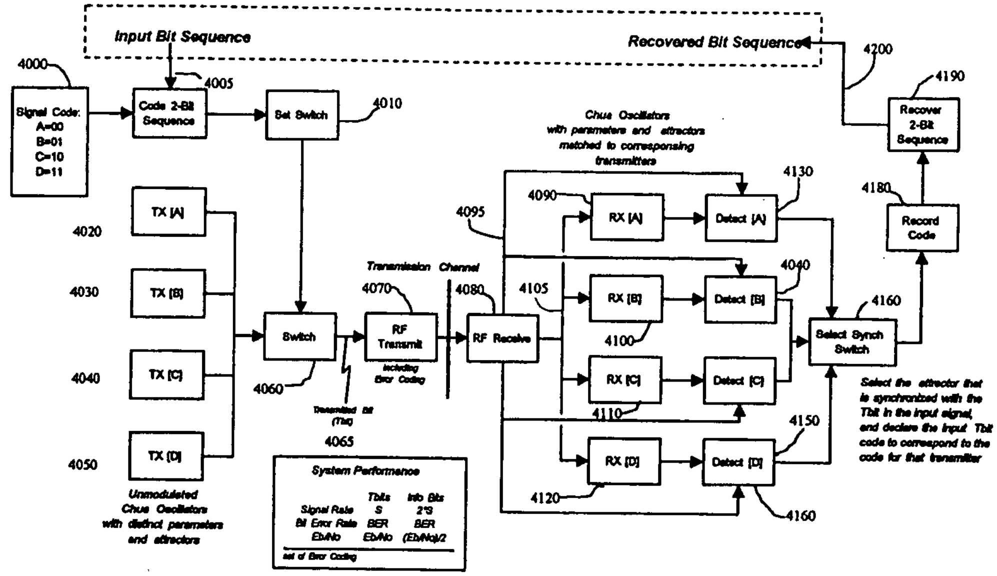

FIG. 38

Another aspect of the invention supports a chaotic telephone device (Figures 18A-18C; page 62, line 1 to page 63, line 29).

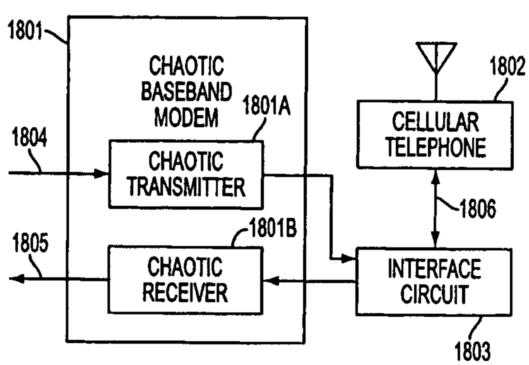

FIG. 18A

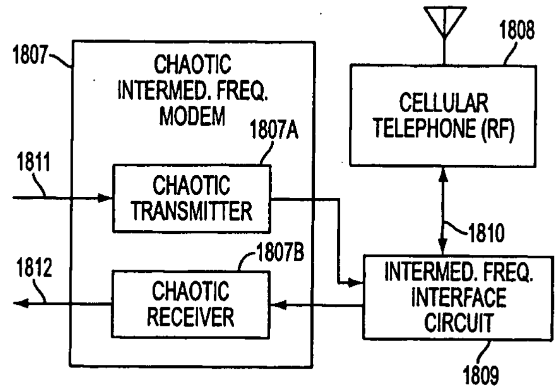

FIG. 18B

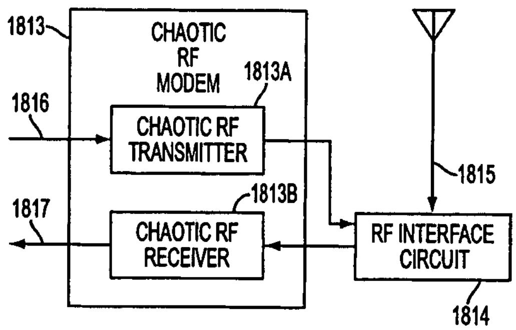

FIG. 18C

The chaotic telephone device includes a chaotic transmitter (e.g., transmitter 1801A) that receives a first information signal and consequently generates a first chaotic trajectory shifted signal that is modulated by the first information signal. The chaotic telephone device also includes a chaotic receiver (e.g., receiver 1801B) that receives a second chaotic trajectory shifted signal and generates a demodulated version of the second chaotic trajectory shifted signal. Both the chaotic receiver and the chaotic transmitter are coupled to an interface circuit (e.g., interface 1803) to a radio-frequency telephone circuit (e.g., cellular telephone 1802).

Another aspect of the invention provides apparatus for interfacing a chaotic transmitting circuit to a communications channel without using a frequency filter (Figure 31; page 68, line 17 to page 69, line 23).

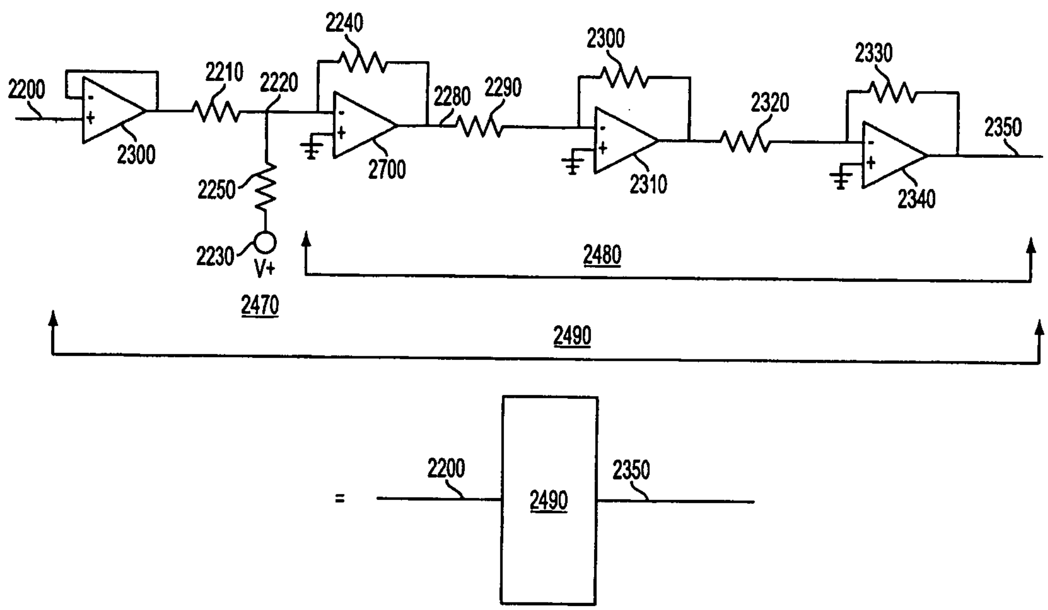

FIG. 31

The apparatus includes an isolation amplifier (amplifier 2300) that buffers an output of the chaotic transmitting circuit from the communications channel, a direct current power supply (supply 2230) that is coupled to the isolation circuit, and an attenuator circuit (subsection 2480) that attenuates a signal present at the direct power supply prior to being introduced into the communications channel.

ISSUES

1) Whether claims 36-44, 54-109, and 111-159 comply with the enablement requirement.

2) Whether claims 36-44, 54-109, and 111-159 particularly point out and distinctly claim the subject matter which applicant regards as the invention.

3) Whether "Chaos Shift Keying Communications System Using Self-Synchronization Chua Oscillators" (Pinkney), or "Secure Communication via Chaotic Parameter Modulation" (Chua), or U.S. Patent No. 5,291,555 (Cuomo), or U.S. Patent No. 6,064,701 (Tresser) teaches all of the features of claims 1-159.

4) Whether the claims are unpatentable over Applicant's Admission of Prior Art.

GROUPING OF CLAIMS

In accordance with 37 CFR §1.192(c)(7), Appellant respectfully asserts that the claims do not stand or fall together. The following groups of separately patentable claims should be recognized. Applicant reserves the right to argue the separate patentability of any claim appearing in the same group.

Group 1 -- Claim 1;

Group 2 -- Claim 2;

Group 3 -- Claims 3, 4;

Group 4 -- Claims 5-8;

Claim 5 -- Claim 9;

Group 6 -- Claims 27-28;

Group 7 -- Claims 29-30;

Group 8 -- Claims 31-32;

Group 9 -- Claims 33-34;

Group 10 -- Claim 35;

Group 11 -- Claim 98;

Group 12 -- Claims 127, 132;

Group 13 -- Claims 140, 142;

Group 14 -- Claims 25, 26, 101-102, 115;

Group 15 -- Claims 10, 14;

Group 16 -- Claims 11, 39;

Group 17 -- Claims 12, 40;

Group 18 -- Claim 13;

Group 19 -- Claim 38;

Group 20 -- Claims 15, 24, 99, 114, 126, 141;

Group 21 -- Claims 16, 22, 23;

Group 22 -- Claim 17;

Group 23 -- Claims 18-21;

Group 24 -- Claim 100;

Group 25 -- Claim 131;

Group 26 -- Claims 36-37;

Group 27 -- Claim 41;

Group 28-- Claims 42-44;

Group 29 – Claims 45-48;

Group 30 -- Claims 49-53;

Group 31 -- Claims 54-56;

Group 32 -- Claims 57-60, 64-66;

Group 33 -- Claim 61;

Group 34 -- Claim 62;

Group 35 -- Claim 63;

Group 36 -- Claims 67, 71-74;

Group 37 -- Claim 68;

Group 38 -- Claim 69;

Group 39 -- Claim 70;

Group 40 -- Claims 75, 78, 128-129, 143;

Group 41 -- Claims 76, 81;

Group 42 -- Claims 77, 82;

Group 43 -- Claims 79, 80;

Group 44 -- Claims 83-86, 89-90, 92, 94-96;

Group 45 -- Claims 87, 88, 91, 93;

Group 46 -- Claims 103-105;

Group 47 -- Claim 110;

Group 48 -- Claims 144, 145, 146, 147;

Group 49 -- Claims 106, 112;

Group 50 -- Claims 107-109;

Group 51 -- Claim 111;

Group 52 -- Claims 116-124, 133-139;

Group 53 -- Claims 148-151;

Group 54 -- Claims 152-155;

Group 55 -- Claims 156-159.

Group 56 -- Claim 97;

Group 57 -- Claim 113; and

Group 58 -- Claims 125 and 130.

ARGUMENT

A. The Office Action misconstrues the step of "changing, in response to an information signal, a non-reactive resistive value in the circuit and thereby causing the first equilibrium point to shift to a shifted first equilibrium point in the current-voltage phase space" to include non-resistive circuits

In the "Response to Arguments" of the Final Office Action (page 3), the Examiner states that "Pinknet [Pinkney] et al disclose an information signal; changing a **non-resistive** value such as two linear capacitors, a non-resistive circuit by modulation", that Chua (page 2) "disclose an information signal (see line 2 of the introduction on page 17 where the message signal is the informational signal); changing a **non-resistive** value such as two linear capacitors, a non-resistive circuit by modulation (see page 17-18, equation 7-10; fig. 1)", that Cuomo (page 2) "disclose an information signal (see line 2 of the introduction on page 17 where the message signal is the informational signal); changing a **non-resistive** value such as two linear capacitors, a non-resistive circuit by modulation (see col. 4, lines [line numbers missing]", and that Tresser (page 3) "disclose an information signal (see fig. 1-3); changing a **non-resistive** value such as two linear capacitors, a non-resistive circuit by modulation (see fig. 4 and 5 where C1 and C2 in fig. 4 and Ck in fig. 5)". (Emphasis added.) The above alleged features are diametrically opposed

to what is claimed in claim 1, in which a non-reactive resistive value (not a non-resistive) is changed. For example, claim 1 includes the feature of "changing, in response to an information signal, a non-reactive resistive value in the circuit and thereby causing the first equilibrium point to shift to a shifted first equilibrium point in the current-voltage phase space". This feature includes a pure resistive value that does not include any reactance and thus does not have either a capacitive or inductive component.

B. The Office Action fails show anticipation or obviousness of claims 1-159

1. The Office Action fails to show a correspondence to any element of the rejected claims in Group 1 with any of the cited references

Group 1 contains claim 1. The Office Action fails to show anticipation by Pinkney, Chua, Cuomo, or Tresser. The Office Action alleges that Pinkney (page 1021-1022, in specific left hand col. of page 1021), Chua (pages 817-819), Cuomo (abstract; fig. 1-6 and col. 3-4), and Tresser (abstract; fig. 2-8 and col. 3-7) disclose (Pages 5-7.):

> a method, a chaotic transmitting circuit, a non-linear element, a chaotic communication system, a chaotic receiver and transmitter, a chaotic telephone device, a method of demodulating a signal modulated according to a chaotic trajectory shift-keying technique, an apparatus and method of recovering information transmitted through a communication wherein generating a chaotic carrier signal that causes oscillation of a voltage about a first equilibrium point and changing in response to an information signal, a non-reactive resistive value in the circuit, shifting to a shifted first equilibrium point in the current-voltage phase space and oscillating between two equilibrium points wherein the current-voltage comprising of three linear segments and all limitations of claims 4-159

The Office Action does not provide further discussion. The Office Action does not discuss any specific teaching in Pinkney, Chua, Cuomo, or Tresser that teaches the feature of "causing the first equilibrium point to shift to a shifted equilibrium point in the current-voltage phase space". Moreover, the Applicant cannot find any corresponding teaching in Pinkney, Chua, Cuomo, or Tresser. While the double-scroll Chua's attractor shown in fig. 2 of Chua appears to have a first equilibrium point, the Office Action does not provide any teaching for the feature of "causing the

first equilibrium point to shift to a shifted first equilibrium point in the current-voltage phase space". Moreover, the Office Action has not provided teachings that suggest the above features.

2. The Office Action fails to show a correspondence to any element of the rejected claims in Group 2 with any of the cited references

Group 2 contains claim 2. The Office Action fails to show anticipation of claim 2. The Office Action merely alludes to all of the features claimed in claims 4-159. The Office Action alleges that Pinkney (page 1021-1022, in specific left hand col. of page 1021), Chua (pages 817-819), Cuomo (abstract; fig. 1-6 and col. 3-4), and Tresser (abstract; fig. 2-8 and col. 3-7) disclose (Pages 5-7. Emphasis added.):

> a method, a chaotic transmitting circuit, a non-linear element, a chaotic communication system, a chaotic receiver and transmitter, a chaotic telephone device, a method of demodulating a signal modulated according to a chaotic trajectory shift-keying technique, an apparatus and method of recovering information transmitted through a communication wherein generating a chaotic carrier signal that causes oscillation of a voltage about a first equilibrium point and changing in response to an information signal, a non-reactive resistive value in the circuit, shifting to a shifted first equilibrium point in the current-voltage phase space and oscillating between two equilibrium points wherein the current-voltage comprising of three linear segments and all limitations of claims 4-159

The Office Action does not provide any further discussion. In order to show anticipation, all of the features of claim 2 must be taught by Pinkney, Chua, Cuomo, or Tresser. However, the Office Action fails to even mention the feature of "causing both equilibrium points to shift in the current-voltage phase space". Moreover, the Office Action has not provided teachings that suggest the above features.

3. The Office Action fails to show a correspondence to any element of the rejected claims in Group 3 with any of the cited references

Group 3 contains claims 3 and 4. The Office Action fails to show anticipation of claims 3-4. The Office Action alleges that Pinkney (page 1021-1022, in specific left hand col. of page 1021), Chua (pages 817-819), Cuomo (abstract; fig. 1-6 and col. 3-4), and Tresser (abstract; fig. 2-8 and col. 3-7) disclose (Pages 5-7. Emphasis added.):

> a method, a chaotic transmitting circuit, a non-linear element, a chaotic communication system, a chaotic receiver and transmitter, a chaotic telephone device, a method of demodulating a signal modulated according to a chaotic trajectory shift-keying technique, an apparatus and method of recovering information transmitted through a communication wherein generating a chaotic carrier signal that causes oscillation of a voltage about a first equilibrium point and changing in response to an information signal, a non-reactive resistive value in the circuit, shifting to a shifted first equilibrium point in the current-voltage phase space and oscillating between two equilibrium points wherein the current-voltage comprising of three linear segments and all limitations of claims 4-159

The Office Action does not provide any further discussion. In order to show anticipation, all features of claims 3 and 4 must be taught by Pinkney, Chua, Cuomo, or Tresser. However, the Office Action fails to even mention the feature of "changing either the first slope or the second slope but not both slopes in response to the information signal" as claimed in claim 3 and the feature of "changing both the first slope and the second slope in response to the information signal" as claimed in claim 4. Moreover, the Office Action has not provided teachings that suggest the above features.

4. The Office Action fails to show a correspondence to any element of the rejected claims in Group 4 with any of the cited references

Group 4 contains claims 5-8, in which claims 6-8 depend from claim 5. The Office Action fails to show anticipation of claims 5-8 by Pinkney, Chua, Cuomo, and Tresser. The Office Action merely alludes to all of the features claimed in claims 4-159. The Office Action alleges that Pinkney (page 1021-1022, in specific left hand col. of page 1021), Chua (pages 817-819), Cuomo (abstract; fig. 1-6 and col. 3-4), and Tresser (abstract; fig. 2-8 and col. 3-7) disclose (Pages 5-7. Emphasis added.):

> a method, a chaotic transmitting circuit, a non-linear element, a chaotic communication system, a chaotic receiver and transmitter, a chaotic telephone device, a method of demodulating a signal modulated according to a chaotic trajectory shift-keying technique, an apparatus and method of recovering information transmitted through a communication wherein generating a chaotic carrier signal that causes oscillation of a voltage about a first equilibrium point and changing in response to an information signal, a non-reactive resistive value in the circuit, shifting to a shifted first equilibrium point in the current-voltage phase space and oscillating

between two equilibrium points wherein the current-voltage comprising of three linear segments **and all limitations of claims 4-159**

The Office Action does not provide any further discussion. For example, the Office Action fails to show prior art that teaches the feature of "switching a non-reactive resistive element in the circuit which changes a slope of the current-voltage characteristic curve for the circuit element" as claimed in claim 5. Moreover, the Office Action has not provided teachings that suggest the above features.

5. The Office Action fails to show a correspondence to any element of the rejected claims in Group 5 with any of the cited references

Group 5 contains claim 9. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 9 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "shorting at least two diodes arranged in opposite polarity" as claimed in claim 9. Moreover, the Office Action has not provided teachings that suggest the above features.

6. The Office Action fails to show a correspondence to any element of the rejected claims in Group 6 with any of the cited references

Group 6 contains claims 27 and 28, in which claim 28 depends from claim 27. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 27 and 28 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "a first op amp coupled across the oscillator circuit through the resistor, wherein the first op amp is further coupled to a first group of three resistors, a first of which is coupled between an output of the first op amp and a positive input terminal thereof; a second of which is coupled between the output of the first op amp and a negative input terminal thereof; and a third of which is coupled between the negative input terminal and a ground" and "a second op amp coupled across the oscillator circuit through the resistor, wherein the second op amp is further coupled to a second group of three resistors, a first of which is coupled between an output of the second op amp and a positive input terminal

thereof; a second of which is coupled between the output of the second op amp and a negative input terminal thereof; and a third of which is coupled between the negative input terminal and the ground" as claimed in claim 27. Moreover, the Office Action has not provided teachings that suggest the above features.

7. The Office Action fails to show a correspondence to any element of the rejected claims in Group 7 with any of the cited references

Group 7 contains claims 29 and 30, in which claim 30 depends from claim 29. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 29 and 30 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "a first diode arranged in a forward polarity across the oscillator circuit through a first resistor and coupled to a first voltage supply through a second resistor", "a second diode arranged in a reversed polarity across the oscillator circuit through a third resistor and coupled to a second voltage supply through a fourth resistor", and "an op amp coupled to a first group of three resistors, a first of which is coupled between an output of the op amp and a positive input terminal thereof; a second of which is coupled between the output of the op amp and a negative input terminal thereof; and a third of which is coupled between the negative input terminal and ground" as claimed in claim 29. Moreover, the Office Action has not provided teachings that suggest the above features.

8. The Office Action fails to show a correspondence to any element of the rejected claims in Group 8 with any of the cited references

Group 8 contains claims 31 and 32. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 31 and 32 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "two forward biased diodes coupled across the oscillator circuit through a first resistor", "two reverse biased diodes coupled across the oscillator circuit through a second resistor", and "an op amp coupled across the oscillator circuit through a resistive feedback network" as claimed in claim 31 and the feature of "two diodes arranged in opposite polarity

across the oscillator circuit through corresponding resistors, wherein the switch shorts the two diodes in response to the information signal and causes the chaotic transmitting circuit to stop oscillating in a chaotic manner" as claimed in claim 32. Moreover, the Office Action has not provided teachings that suggest the above features.

9. The Office Action fails to show a correspondence to any element of the rejected claims in Group 9 with any of the cited references

Group 9 contains claim 33 and 34, in which claim 34 depends from claim 33. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 33 and 34 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "the oscillator and chaotic circuit comprise circuit elements having values selected so as to cause the chaotic transmitting circuit to oscillate in a single-scroll attractor mode" as claimed in claim 33. Moreover, the Office Action has not provided teachings that suggest the above features.

10. The Office Action fails to show a correspondence to any element of the rejected claims in Group 10 with any of the cited references

Group 10 contains claim 35. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 35 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "the oscillator and chaotic circuit comprise circuit elements having values selected so as to cause the chaotic transmitting circuit to oscillate in a double-scroll attractor mode" as claimed in claim 35. Moreover, the Office Action has not provided teachings that suggest the above features.

11. The Office Action fails to show a correspondence to any element of the rejected claims in Group 11 with any of the cited references

Group 11 contains claim 98. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 27 and 28 by Pinkney, Chua, Cuomo,

and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "changing the non-reactive resistive value to one of a plurality of uniquely coded vectors within a chaotic operating region which, when received at a matched receiver, will generate a corresponding unique code" as claimed in claim 98. Moreover, the Office Action has not provided teachings that suggest the above features.

12. The Office Action fails to show a correspondence to any element of the rejected claims in Group 12 with any of the cited references

Group 12 contains claims 127 and 132, in which claim 132 depends from claim 127. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 127 and 132 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "the switch switches a voltage source to shift to the shifted first equilibrium point" as claimed in claim 127. Moreover, the Office Action has not provided teachings that suggest the above features.

13. The Office Action fails to show a correspondence to any element of the rejected claims in Group 13 with any of the cited references

Group 13 contains claim 140 and 142. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 140 and 142 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "using a circuit that exhibits a positive linear slope" and "changing the positive linear slope" as claimed in claim 140 and the feature of "the chaotic circuit exhibits a positive linear slope" as claimed in claim 142. Moreover, the Office Action has not provided teachings that suggest the above features.

14. The Office Action fails to show a correspondence to any element of the rejected claims in Group 14 with any of the cited references

Group 14 contains claims 25, 26, 101, 102, and 115, in which claims 26, 101, 102, and 115 depend from claim 25. As previously discussed with the claims of Group 4, the Office

Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 22, 26, 101, 102, and 115 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an oscillator circuit", and "a resistor coupled to the oscillator circuit", "a chaotic circuit coupled to the oscillator circuit through the resistor, wherein the chaotic circuit exhibits a current-voltage characteristic shape having a slope that intersects a load line defined by the resistor and provides an equilibrium point about which a voltage oscillates chaotically", and "a switch coupled to the chaotic circuit, wherein the switch changes a nonreactive resistive value in the chaotic circuit in accordance with an information signal and thereby causes the first equilibrium point to shift to a shifted first equilibrium point" as claimed in claim 25. Moreover, the Office Action has not provided teachings that suggest the above features.

15. The Office Action fails to show a correspondence to any element of the rejected claims in Group 15 with any of the cited references

Group 15 contains claims 10 and 14. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 10 and 14 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "transmitting a signal resulting from the changed non-reactive resistive value through a communication channel", "receiving the signal transmitted in step (3) in a receiver tuned to synchronize with the chaotic carrier signal generated in step (1)", and "providing a demodulated output containing the information signal by detecting periods of synchronization and non-synchronization with the received signal" as claimed in claim 10 and the feature of "changing a breakpoint voltage of a piecewise linear response curve of the circuit" as claimed in claim 14. Moreover, the Office Action has not provided teachings that suggest the above features.

16. The Office Action fails to show a correspondence to any element of the rejected claims in Group 16 with any of the cited references

Group 16 contains claims 11 and 39. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 11 and 39 by Pinkney,

Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "transmitting a single-scroll attractor chaotic signal", "receiving the single-scroll attractor chaotic signal transmitted in step (3)", and "detecting periods of synchronization and non-synchronization with the single-scroll attractor chaotic signal" as claimed in claim 11 and the features of "the transmitter and the receiver each oscillate chaotically about a single-scroll attractor" as claimed in claim 39. Moreover, the Office Action has not provided teachings that suggest the above features.

17. The Office Action fails to show a correspondence to any element of the rejected claims in Group 17 with any of the cited references

Group 17 contains claims 12 and 40. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 12 and 40 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "transmitting a double-scroll attractor chaotic signal", "receiving the double-scroll attractor chaotic signal transmitted in step (3)", and "detecting periods of synchronization and non-synchronization with the double-scroll attractor chaotic signal" as claimed in claim 12 and the feature of "the transmitter and the receiver each oscillate chaotically about double-scroll attractors" as claimed in claim 40. Moreover, the Office Action has not provided teachings that suggest the above features.

18. The Office Action fails to show a correspondence to any element of the rejected claims in Group 18 with any of the cited references

Group 18 contains claim 13. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 13 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "transmitting a triple-scroll attractor chaotic signal", "receiving the triple scroll attractor chaotic transmitted in step (3)", and "detecting periods of synchronization and non-synchronization with the triple-scroll attractor chaotic signal" as claimed in claim 13. Moreover, the Office Action has not provided teachings that suggest the above features.

19. The Office Action fails to show a correspondence to any element of the rejected claims in Group 19 with any of the cited references

Group 19 contains claim 38. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 38 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an oscillator circuit", "a resistor coupled to the oscillator circuit", a chaotic circuit coupled to the oscillator circuit through the resistor, wherein the chaotic circuit causes a voltage to oscillate about a first equilibrium point on a current-voltage characteristic curve of the chaotic circuit element", and "a switch coupled to the chaotic circuit element, wherein the switch changes a nonreactive resistive value in the chaotic circuit in accordance with an information signal and thereby causes the first equilibrium point to shift to a shifted first equilibrium point" for a transmitter and "a second oscillator circuit", "a second resistor coupled to the second oscillator circuit", a second chaotic circuit coupled to the second oscillator circuit through the second resistor", "a detector coupled to the second oscillator circuit and the second chaotic circuit", "wherein the second oscillator circuit and the second chaotic circuit comprise circuit components selected such that they cause the receiver to synchronize with the transmitter when the transmitter transmits according to the first equilibrium point", and "wherein the detector detects whether the receiver is synchronized and, in response to detecting synchronization, generates a signal" for a receiver as claimed in claim 38. Moreover, the Office Action has not provided teachings that suggest the above features.

20. The Office Action fails to show a correspondence to any element of the rejected claims in Group 20 with any of the cited references

Group 20 contains claims 15, 24, 99, 114, 126, and 141, in which claims 24, 99, 114, 126, and 141 depend from claim 15. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 15, 24, 99, 114, 126, and 141 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an oscillator circuit", a resistor coupled to the oscillator circuit", "a

chaotic circuit, coupled to the oscillator circuit through the resistor, wherein the chaotic circuit exhibits a current-voltage characteristic shape having a slope that intersects a load line defined by the resistor and provides an equilibrium point about which a voltage oscillates chaotically", and "means for changing the slope exhibited by the chaotic circuit in accordance with an information signal" as claimed in claim 15. Moreover, the Office Action has not provided teachings that suggest the above features.

21. The Office Action fails to show a correspondence to any element of the rejected claims in Group 21 with any of the cited references

Group 21 contains claims 16, 22, and 23, in which claim 23 depends from claim 22. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 16, 22, and 23 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "the oscillator circuit comprises an inductance and a first capacitance", "the chaotic circuit comprises a second capacitance", and "the values of the first capacitance, the second capacitance, the inductance, and the resistance are selected so as to cause the chaotic transmitting circuit to oscillate in a single-scroll attractor mode" as claimed in claim 16 and the feature of "the chaotic circuit comprises circuit elements having values selected so as to cause the chaotic transmitting circuit to oscillate about a single-scroll attractor" as claimed in claim 22. Moreover, the Office Action has not provided teachings that suggest the above features.

22. The Office Action fails to show a correspondence to any element of the rejected claims in Group 22 with any of the cited references

Group 22 contains claim 17. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 17 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "the oscillator circuit comprises an inductance and a first capacitance", "the chaotic circuit comprises a second capacitance", and "the values of the first capacitance, the second capacitance, the inductance, and the resistance are selected so as to cause the chaotic transmitting circuit to

oscillate in a double-scroll attractor mode" as claimed in claim 17. Moreover, the Office Action has not provided teachings that suggest the above features.

23. The Office Action fails to show a correspondence to any element of the rejected claims in Group 23 with any of the cited references

Group 23 contains claim 18, 19, 20, and 21, in which claims 19, 20, and 21 depend from claim 18. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 18, 19, 20, and 21 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "the means for changing comprises means for switching a plurality of resistive values" as claimed in claim 18. Moreover, the Office Action has not provided teachings that suggest the above features.

24. The Office Action fails to show a correspondence to any element of the rejected claims in Group 24 with any of the cited references

Group 24 contains claim 100. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 100 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "the means for changing sets the non-reactive resistive value to one of a plurality of uniquely coded vectors within a chaotic operating region which, when received at a matched receiver, will generate a corresponding unique code as claimed in claim 100. Moreover, the Office Action has not provided teachings that suggest the above features.

25. The Office Action fails to show a correspondence to any element of the rejected claims in Group 25 with any of the cited references

Group 25 contains claim 131. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 131 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "a filter coupled to an output of the chaotic circuit that limits a frequency bandwidth thereof" as claimed

in claim 131. Moreover, the Office Action has not provided teachings that suggest the above features.

26. The Office Action fails to show a correspondence to any element of the rejected claims in Group 26 with any of the cited references

Group 26 contains claim 36 and 37, in which claim 37 depends from claim 36. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 36 and 37 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "a first pair of diodes coupled in series and biased in a forward direction with respect to first and second circuit terminals", "a second pair of diodes coupled in series and biased in a reverse direction with respect to the first and second circuit terminals", "a first resistor coupled between the first pair of diodes and one of the circuit terminals", "a second resistor coupled between the second pair of diodes and one of the circuit terminals", "an op amp coupled between the first and second circuit terminals through a resistive network" and "wherein the first resistor, the second resistor, and the resistive network have values selected to bias the nonlinear circuit element such that it exhibits a piecewise linear current-voltage characteristic across the first and second terminals" as claimed in claim 36. Moreover, the Office Action has not provided teachings that suggest the above features.

27. The Office Action fails to show a correspondence to any element of the rejected claims in Group 27 with any of the cited references

Group 27 contains claim 41. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 41 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an input terminal for receiving a chaotically modulated signal", "an oscillating circuit coupled to the input terminal", "a chaotic circuit comprising a capacitor and a negative resistance element, wherein the chaotic circuit is coupled to the oscillating circuit through a resistor, wherein the chaotic circuit causes a voltage to oscillate about an equilibrium point corresponding to a current-voltage characteristic curve of the negative resistance element", "a synchronizing resistor

coupled between the input terminal and the negative resistance element", "a comparator, coupled across the synchronizing resistor, wherein the comparator generates an output signal when a voltage drop across the synchronizing resistor reaches a predetermined level", and "wherein the synchronizing resistor has a value that satisfies the relation Rsync $\leq (1/(2f_{LC} \times C_1))$ where f_{LC} is the fundamental frequency of the oscillator circuit, and where C_1 is the capacitance of the capacitor" as claimed in claim 41. Moreover, the Office Action has not provided teachings that suggest the above features.

28. <u>The Office Action fails to show a correspondence to any element of the rejected claims in Group 28 with any of the cited references</u>

Group 28 contains claims 42, 43, and 44, in which claim 43 depends from claim 42. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 42, 43, and 44 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an input terminal that receives a modulated chaotic signal", "an oscillator coupled to the input terminal", "a chaotic circuit comprising a capacitor and a negative resistance circuit", "a gain control amplifier coupled between the oscillator and the chaotic circuit, wherein the gain control amplifier amplifies a voltage present at the oscillator before it reaches the chaotic circuit", "a synchronizing resistor coupled between the input terminal and the chaotic circuit", "a detection circuit, coupled to the synchronizing resistor, wherein the detection circuit detects periods of synchronization and non-synchronization between the modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization" as claimed in claim 42 and the features of "a transmitter that generates a chaotic carrier signal modulated in accordance with an information signal" and "a receiving system having an input terminal that receives the chaotic carrier signal modulated by the transmitter, wherein the receiving system comprises an oscillator subsystem coupled to the input terminal; a gain control amplifier coupled to the output of the oscillator subsystem; a chaotic subsystem coupled to the output of the gain control amplifier; a synchronizing subsystem coupled to the chaotic subsystem and to the input terminal, which causes the chaotic subsystem to synchronize to the chaotic carrier signal; and a detector coupled to the chaotic subsystem and the input terminal, wherein the detector detects

periods of synchronization and non-synchronization; wherein the gain control amplifier amplifies a signal produced by the oscillator subsystem and drives the chaotic subsystem with the amplified signal, and wherein the chaotic subsystem generates a signal that synchronizes with the modulated chaotic signal when the transmitter transmits a symbol of information" as claimed in claim 44. Moreover, the Office Action has not provided teachings that suggest the above features.

29. The Office Action fails to show a correspondence to any element of the rejected claims in Group 29 with any of the cited references

Group 29 contains claims 45, 46, 47, and 48, in which claim 46, 47, and 48 depend from claim 45. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 45, 46, 47, and 48 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an oscillator", "a resistor coupled to the oscillator", "a chaotic circuit comprising a negative resistance, wherein the chaotic circuit is coupled to the oscillator circuit through the resistor", "an isolation amplifier coupled to the chaotic circuit", "a filter coupled to the output of the isolation amplifier that limits a frequency bandwidth present at the chaotic circuit", and "means for modulating a circuit element of the chaotic transmitter in accordance with an information signal" as claimed in claim 45. Moreover, the Office Action has not provided teachings that suggest the above features.

30. The Office Action fails to show a correspondence to any element of the rejected claims in Group 30 with any of the cited references

Group 30 contains claims 49, 50, 51, 52, and 53, in which claims 52 and 53 depend from claim 51. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 49, 50, 51, 52, and 53 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "the means for modulating comprises a switch that switches a reactive component in the oscillator, thereby changing a strange attractor trajectory generated by the transmitter" as claimed in claim 49, the feature of "the means for modulating comprises a switch that switches a reactive component in

the chaotic circuit, thereby changing a strange attractor trajectory generated by the transmitter" as claimed in claim 50, and the feature of "the means for modulating comprises a switch that changes a non-reactive resistive value in the chaotic circuit, thereby changing a current-voltage characteristic of the negative resistive element" as claimed in claim 51. Moreover, the Office Action has not provided teachings that suggest the above features.

31. The Office Action fails to show a correspondence to any element of the rejected claims in Group 31 with any of the cited references

Group 31 contains claims 54, 55, and 56. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 54, 55, and 56 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an input terminal that receives a modulated chaotic signal", "a first filter, coupled to the input terminal, which filters the modulated chaotic signal and produces a filtered modulated chaotic signal", "an oscillator coupled to an output of the first filter", "a chaotic circuit comprising a negative resistor, wherein the chaotic circuit is coupled to the oscillator", "a synchronizing circuit coupled between the first filter and the chaotic circuit, wherein the synchronizing circuit generates a voltage difference in response to an out-of-synchronization condition between the filtered modulated chaotic signal and the chaotic circuit", "a second filter, coupled to a first portion of the synchronizing circuit, which filters a buffered version of the filtered modulated chaotic signal", "a third filter, coupled to a second portion of the synchronizing circuit, which filters a signal generated by the chaotic circuit", and "a detection circuit, coupled to the second and third filters, wherein the detection circuit detects periods of synchronization and non-synchronization between the modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization" as claimed in claim 54, the features of "an input terminal that receives a modulated chaotic signal", "a first filter, coupled to the input terminal, which filters the modulated chaotic signal and produces a filtered modulated chaotic signal", "an oscillator coupled to the input terminal", "a chaotic circuit comprising a circuit element that exhibits a nonlinear current-voltage characteristic, wherein the chaotic circuit is coupled to the oscillator", "a synchronizing circuit coupled between the first filter and the chaotic circuit, wherein the

synchronizing circuit generates a voltage difference in response to an out-of-synchronization condition between the filtered modulated chaotic signal and the chaotic circuit", "a second filter, coupled to a first portion of the synchronizing circuit, which filters a buffered version of the filtered modulated chaotic signal", "a third filter, coupled to a second portion of the synchronizing circuit, which filters a signal generated by the chaotic circuit", "a detection circuit, coupled to the second and third filters, wherein the detection circuit detects periods of synchronization and non-synchronization between the modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization" as claimed in claim 55, and the features of "an input terminal that receives a modulated chaotic signal", "a first filter, coupled to the input terminal, which filters the modulated chaotic signal and produces a filtered modulated chaotic signal", "an oscillating circuit coupled to the first filter", "a chaotic circuit comprising a circuit element that exhibits a nonlinear current-voltage characteristic, wherein the chaotic circuit is coupled to the oscillating circuit through a second filter", "a third filter, coupled to the output of the first filter, which further filters the output of the first filter", "a synchronizing circuit coupled between the third filter and the chaotic circuit, wherein the synchronizing circuit generates a voltage difference in response to an out-of-synchronization condition between a signal from the third filter and the chaotic circuit", "a fourth filter, coupled to a first portion of the synchronizing circuit, which filters a buffered version of the filtered modulated chaotic signal", "a fifth filter, coupled to a second portion of the synchronizing circuit, which filters a signal generated by the chaotic circuit", "a detection circuit, coupled to the fourth and fifth filters, wherein the detection circuit detects periods of synchronization and non-synchronization between the modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization" as claimed in claim 56. Moreover, the Office Action has not provided teachings that suggest the above features.

32. The Office Action fails to show a correspondence to any element <u>of the rejected claims in Group 32 with any of the cited references</u>

Group 32 contains claims 57, 58, 59, 60, 64, 65, and 66, in which claims 58, 59, 60, 64, 65, and 66 depend from 57. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the

Office Action fails to show anticipation of claims 57, 58, 59, 60, 64, 65, and 66 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "a chaotic transmitter that receives a first information signal and generates in response thereto a first chaotic trajectory shifted signal modulated in accordance with the first information signal", "a chaotic receiver that receives a second chaotic trajectory shifted signal modulated in accordance with a second information signal and generates in response thereto a demodulated version of the second chaotic trajectory shifted signal", and "an interface circuit that couples the chaotic transmitter and chaotic receiver to a radio-frequency telephone circuit, wherein the radio-frequency telephone circuit communicates with a ground-based telephone network through one or more radio frequency transmission stations' as claimed in claim 57. Moreover, the Office Action has not provided teachings that suggest the above features.

33. The Office Action fails to show a correspondence to any element of the rejected claims in Group 33 with any of the cited references

Group 33 contains claim 61. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 61 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "the chaotic transmitter and the chaotic receiver respectively modulate and demodulate signals in a single-scroll strange attractor phase space" as claimed in claim 61. Moreover, the Office Action has not provided teachings that suggest the above features.

34. The Office Action fails to show a correspondence to any element of the rejected claims in Group 34 with any of the cited references

Group 34 contains claim 62. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 62 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "the chaotic transmitter and the chaotic receiver respectively modulate and demodulate signals in a double-scroll strange attractor phase space" as claimed in claim 62. Moreover, the Office Action has not provided teachings that suggest the above features.

35. The Office Action fails to show a correspondence to any element of the rejected claims in Group 35 with any of the cited references

Group 35 contains claim 63. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 63 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "the chaotic transmitter modulates using a first set of strange attractor parameters that match a set of strange attractor parameters in a corresponding receiver associated with the one or more radio frequency transmission stations", and "the chaotic receiver demodulates using a second set of strange attractor parameters in a corresponding transmitter associated with the one or more radio frequency transmission stations" as claimed in claim 63. Moreover, the Office Action has not provided teachings that suggest the above features.

36. The Office Action fails to show a correspondence to any element of the rejected claims in Group 36 with any of the cited references

Group 36 contains claim 67, 71, 72, 73, and 74, in which claim 71, 72, 73, and 74 depend from claim 67. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 67, 71, 72, 73, and 74 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "generating an information signal at the portable telephone device", "modulating a chaotic carrier signal with the information signal using a chaotic trajectory shifting technique", "transmitting the chaotic trajectory shift-keyed signal generated in step (2) to the base station", and "in the base station, demodulating the transmitted signal to recover the information signal" as claimed in claim 67. Moreover, the Office Action has not provided teachings that suggest the above features.

37. The Office Action fails to show a correspondence to any element of the rejected claims in Group 37 with any of the cited references

Group 37 contains claim 68. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation.

Thus, the Office Action fails to show anticipation of claim 68 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "changing a non-reactive resistive value in a chaotic circuit element to cause a strange attractor trajectory shift" as claimed in claim 68. Moreover, the Office Action has not provided teachings that suggest the above features.

38. The Office Action fails to show a correspondence to any element of the rejected claims in Group 38 with any of the cited references

Group 38 contains claim 69. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 69 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "generating a chaotic carrier signal that oscillates about two equilibrium points in a current-voltage phase space, and further comprising the step of causing both equilibrium points to shift in the current-voltage phase space" as claimed in claim 69. Moreover, the Office Action has not provided teachings that suggest the above features.

39. The Office Action fails to show a correspondence to any element of the rejected claims in Group 39 with any of the cited references

Group 39 contains claim 70. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 70 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "using a nonlinear circuit element that exhibits a piecewise linear current-voltage characteristic comprising three linear segments, two of the segments having a first slope in the phase space and the third segment having a second slope in the phase space" and "changing either the first slope or the second slope but not both slopes in response to the information signal" as claimed in claim 70. Moreover, the Office Action has not provided teachings that suggest the above features.

40. The Office Action fails to show a correspondence to any element of the rejected claims in Group 40 with any of the cited references

Group 40 contains claims 75, 78, 128, 129, and 143, in which claims 78, 128, and 143 depend from claim 75. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 75, 78, 128, 129, and 143 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "a first chaotic circuit that generates a first chaotic signal having a first strange attractor trajectory", "a second chaotic circuit that generates a second chaotic signal having a second strange attractor trajectory different from that of the first strange attractor trajectory", "a switch coupled to the first and second chaotic circuits, wherein the switch selects either the first chaotic signal or the second chaotic signal in response to an information signal", and "a low-pass filter coupled to the output of the switch" as claimed in claim 75 and the features of "generating a first chaotic signal that oscillates about a first equilibrium point in an upper quadrant of a current-voltage phase space of a chaotic circuit element" and "generating a second chaotic signal that oscillates about a second equilibrium point in a lower quadrant of the current-voltage phase space" as claimed in claim 129. Moreover, the Office Action has not provided teachings that suggest the above features.

41. The Office Action fails to show a correspondence to any element of the rejected claims in Group 41 with any of the cited references

Group 41 contains claims 76 and 81. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 76 and 81 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "the first and second chaotic circuits each generate a single-scroll strange attractor chaotic signal" as claimed in claim 76 and the feature of "generating a single-scroll strange attractor chaotic signal" as claimed in claim 81. Moreover, the Office Action has not provided teachings that suggest the above features.

42. <u>The Office Action fails to show a correspondence to any element of the rejected claims in Group 42 with any of the cited references</u>

Group 42 contains claims 77 and 82. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 77 and 82 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the feature of "the first and second chaotic circuits each generate a double-scroll strange attractor chaotic signal" as claimed in claim 77 and the feature of "generating a double-scroll strange attractor chaotic signal" as claimed in claim 82. Moreover, the Office Action has not provided teachings that suggest the above features.

43. <u>The Office Action fails to show a correspondence to any element of the rejected claims in Group 43 with any of the cited references</u>

Group 43 contains claims 79 and 80, in which claim 80 depends from claim 79. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 79 and 80 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "generating a first chaotic signal comprising at least one strange attractor that oscillates about a first equilibrium point", "generating a second chaotic signal comprising at least a second strange attractor that oscillates about a second equilibrium point", "in response to the information signal, selecting an output of either the first chaotic signal or the second chaotic signal", and "transmitting the selected output from step (3)' as claimed in claim 79. Moreover, the Office Action has not provided teachings that suggest the above features.

44. <u>The Office Action fails to show a correspondence to any element of the rejected claims in Group 44 with any of the cited references</u>

Group 44 contains claims 83, 84, 85, 86, 89, 90, 92, 94, 95, and 96, in which claim 84 and 89 depend from claim 83 and claims 86, 90, 92, and 94 depend from claim 85. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show

anticipation of claims 83, 84, 85, 86, 89, 90, 92, 94, 95, and 96 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an input terminal that receives a modulated chaotic signal", "an oscillator circuit coupled to the input terminal", "a first chaotic circuit coupled to the oscillator circuit and tuned to a first strange attractor", "a second chaotic circuit coupled to the oscillator circuit and tuned to a second strange attractor", and "means for detecting a difference between the modulated chaotic signal received at the input terminal and respective signals generated by the first and second chaotic circuits" as claimed in claim 83, the features of "receiving a modulated chaotic signal modulated according to a chaotic trajectory shift-keying technique", "using the modulated chaotic signal to drive an oscillator", "using the modulated chaotic signal and an output of the oscillator to drive a first chaotic circuit tuned to a first strange attractor", "using the modulated chaotic signal and an output of the oscillator circuit to drive a second chaotic circuit tuned to a second strange attractor", and "detecting a difference between the modulated chaotic signal and respective signals generated by the first and second chaotic circuits" as claimed in claim 85, the features of "an input terminal that receives a modulated chaotic signal", "an oscillator coupled to the input terminal", "a first chaotic circuit coupled to the oscillator and tuned to a first strange attractor", "a second chaotic circuit coupled to the oscillator circuit and tuned to a second strange attractor", and "a detector circuit coupled to the first and second chaotic circuits, wherein the detector circuit subtracts signals present at the first and second chaotic circuits and generates an absolute value signal based on the subtracted signal" are claimed in claim 95, and the features of "receiving a modulated chaotic signal", "using the modulated chaotic signal to drive an oscillator circuit", "using the modulated chaotic signal and an output of the oscillator circuit to drive a first chaotic circuit comprising a first nonlinear circuit element and tuned to a first strange attractor", "using the modulated chaotic signal and an output of the oscillator circuit to drive a second chaotic circuit comprising a second nonlinear circuit element and tuned to a second strange attractor", and "detecting a difference between first and second signals present at the first and second chaotic circuits, respectively, by subtracting the first and second signals and generating an absolute value thereof" as claimed in claim 96. Moreover, the Office Action has not provided teachings that suggest the above features.

45. The Office Action fails to show a correspondence to any element of the rejected claims in Group 45 with any of the cited references

Group 45 contains claims 87, 88, 91, and 93. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 87, 88, 91, and 93 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "a plurality of synchronizing resistors each of which generates a voltage drop in response to a difference between the modulated chaotic signal and a corresponding one of the first and second chaotic circuits", "means for buffering the plurality of synchronizing resistors and generating buffered outputs therefrom", "means for attenuating the buffered outputs", and "means for subtracting the buffered outputs to generate a detected signal" as claimed in claim 87, the features of "generating a voltage drop in response to a difference between the modulated chaotic signal and a corresponding one of the first and second chaotic circuits", "buffering the plurality of synchronizing resistors and generating buffered outputs therefrom", "attenuating the buffered outputs", and "subtracting the buffered outputs to generate a detected signal" as claimed in claim 88, the features of "first and second subtractor circuits, each coupled across a corresponding one of the two synchronizing resistors", "a third subtractor circuit, coupled to the first and second subtractor circuits, wherein the third subtractor circuit generates a difference signal from the first and second subtractor circuits", "an absolute value circuit, coupled to the third subtractor circuit, which generates an absolute value signal from the third subtractor circuit", and "a squaring circuit that generates a squared version of the absolute value signal" as claimed in claim 91, and the features of "first and second subtractor circuits, each coupled across a corresponding one of the two synchronizing resistors", "first and second absolute value circuits, each coupled to a corresponding one of the first and second subtractor circuits", "a third subtractor circuit, coupled to the first and second absolute value circuits, which generates a subtracted absolute value signal", and "a squaring circuit that generates a squared version of the subtracted absolute value signal" as claimed in claim 93. Moreover, the Office Action has not provided teachings that suggest the above features.

46. The Office Action fails to show a correspondence to any element of the rejected claims in Group 46 with any of the cited references

Group 46 contains claims 103, 104, and 105, in which claims 104 and 105 depend from claim 103. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 103, 104, and 105 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "in response to receiving a time-varying N-bit code representing a unit of information, selecting a corresponding one of a plurality of 2^N transmitters each of which generates a chaotic strange attractor signal that is distinct from others in the plurality of 2^N transmitters" and "transmitting through a communications channel the chaotic strange attractor signal selected in step (1)" as claimed in claim 103. Moreover, the Office Action has not provided teachings that suggest the above features.

47. The Office Action fails to show a correspondence to any element of the rejected claims in Group 47 with any of the cited references.

Group 47 contains claim 110. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 110 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "a plurality of 2^N transmitters each of which generates a chaotic strange attractor signal that is distinct from others in the plurality of 2^N transmitters", "a switch which, in response to receiving a time-varying N-bit code representing a unit of information, selects a corresponding one of the plurality of 2^N transmitters", and "a transmission circuit that transmits the selected chaotic strange attractor signal across a transmission channel" as claimed by claim 110. Moreover, the Office Action has not provided teachings that suggest the above features.

48. The Office Action fails to show a correspondence to any element of the rejected claims in Group 48 with any of the cited references

Group 48 contains claims 144, 145, 146, and 147, in which claim 145 and claim 146 depends from claim 144. As previously discussed with the claims of Group 4, the Office Action

merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 144, 145, 146, and 147 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "generating a chaotic carrier signal characterized by a voltage that oscillates chaotically about a first equilibrium point in a current-voltage plane, wherein the first equilibrium point is defined by an intersection of a current-voltage load line having a first slope and a current-voltage slope line having a second slope opposite in polarity to that the of the first slope", "in response to a time-varying information signal comprising an N-bit symbol, selecting one of a plurality of 2^N equilibrium points defined by successive intersections of a plurality of current-voltage slope lines having slopes opposite to that of the load line and that intersect the load line at different points", "shifting the first equilibrium point to the one selected equilibrium point such that the chaotic carrier signal oscillates chaotically about the one selected equilibrium point", and "transmitting the chaotic carrier signal shifted in step (3)" as claimed in claim 144 and the features of "a computer that generates, in response to an information signal, a digital word comprising N bits", "a digital-to-analog converter, coupled to the computer, that converts the digital word into an analog signal selected from one of 2^N possible signal levels", and "means for converting the analog signal into a chaotically oscillating signal that oscillates about a current-voltage equilibrium point defined by an intersection of a resistive load line and a current-voltage function uniquely defined by the analog signal" as claimed in claim 147. Moreover, the Office Action has not provided teachings that suggest the above features.

49. The Office Action fails to show a correspondence to any element of the rejected claims in Group 49 with any of the cited references

Group 49 contains claims 106 and 112. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 106 and 112 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "receiving the chaotic strange attractor signal transmitted in step (2)", "matching the signal received in step (3) to one of a plurality of 2^N receivers each of which is matched to a corresponding one of the plurality of 2^N transmitters", and "on the basis of the receiver matched in step (4), recovering the N-bit code received in step (1)" as claimed in claim

106 and the features of "a receiving circuit that receives a time-varying signal comprising a plurality of discrete portions of each of a plurality of chaotic strange attractor signals", "a plurality of 2^N receivers each of which is tuned to one of the 2^N transmitters", "a plurality of detectors each of which detects whether a corresponding one of the plurality of 2^N receivers has received a matching signal", and "a switching circuit which, in response to one of the detectors detecting a corresponding match, generates an N-bit code representing a transmitted unit of information" as claimed in claim 112. Moreover, the Office Action has not provided teachings that suggest the above features.

50. The Office Action fails to show a correspondence to any element of the rejected claims in Group 50 with any of the cited references

Group 50 contains claims 107, 108, and 109, in which claims 108 and 109 depend from claim 107. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 107, 108, and 109 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "receiving a time-varying signal comprising discrete portions of each of a plurality of chaotic strange attractor signals", "matching the signal received in step (1) to one of a plurality of 2^N receivers each of which is tuned to a different strange attractor signal", and "on the basis of the receiver matched in step (2), generating an N-bit code" as claimed in claim 107. Moreover, the Office Action has not provided teachings that suggest the above features.

51. The Office Action fails to show a correspondence to any element of the rejected claims in Group 51 with any of the cited references

Group 51 contains claim 111. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claim 111 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "a receiving circuit that receives a time-varying signal comprising a plurality of discrete portions of each of a plurality of chaotic strange attractor signals", "a plurality of 2^N receivers each of which is tuned to one of a corresponding number of 2^N transmitters", "a plurality of detectors each of

which detects whether a corresponding one of the plurality of 2^N receivers has received a matching signal", and "a switching circuit which, in response to one of the detectors detecting a corresponding match, generates an N-bit code representing a transmitted unit of information" as claimed in claim 111. Moreover, the Office Action has not provided teachings that suggest the above features.

52. The Office Action fails to show a correspondence to any element of the rejected claims in Group 52 with any of the cited references

Group 52 contains claims 116, 117, 118, 119, 120, 121, 122, 123, 124, 133, 134, 135, 136, 137, 138, and 139, in which claims 117, 118, 119, 120, 121, 122, 133, and 134 depend from claim 116, claim 124 depends from claim 123, claim 136 depends from claim 135, and claims 138 and 139 depend from claim 137. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 116, 117, 118, 119, 120, 121, 122, 123, 124, 133, 134, 135, 136, 137, 138, and 139 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an input terminal that receives a modulated chaotic signal", "an oscillator circuit coupled to the input terminal and driven by the modulated chaotic signal", "a chaotic circuit comprising an upper slope circuit that implements a first current-voltage function in an upper quadrant of a current-voltage response plane and a lower slope circuit that implements a second current-voltage function in a lower quadrant of the current-voltage response plane, wherein the first and second current-voltage functions have a different voltage offset, and wherein the upper and lower slope circuits cooperate with the oscillator circuit to generate a local chaotic signal", "a synchronizing circuit, coupled to the oscillator circuit and the chaotic circuit, wherein the synchronizing circuit detects differences between the modulated chaotic signal at the input terminal and the local chaotic signal", "a detector coupled to the synchronizing circuit which detects periods of synchronization and non-synchronization" as claimed in claim 116, the features of "receiving the chaotically modulated signal", "applying the signal received in step (1) to an oscillator through a resistor that defines a load line", "applying the signal applied to the oscillator in step (2) to first and second slope detector circuits each of which defines a linear current-voltage function that intercepts the load line in a different quadrant of a current-voltage plane", "applying respective outputs of the

first and second slope detector circuits to a synchronizing resistor circuit that generates voltage differences corresponding to differences between each respective slope detector circuit and the chaotically modulated signal received in step (1)", and "detecting an output from the synchronizing resistor circuit to provide a demodulated signal" as claimed in claim 123, the features of "receiving the chaotically modulated signal", "applying the signal received in step (1) to an oscillator through a resistor that defines a current-voltage load line", "applying the signal applied to the oscillator in step (2) to a slope detector circuit that exhibits a current slope function opposite in polarity to that of the load line and which intersects the load line at an equilibrium point corresponding to an equilibrium point of a transmitter", "generating a difference signal representing a difference between the chaotically modulated signal received in step (1) and the output of the slope detector circuit", and "recovering an information signal on the basis of the difference signal generated in step (4)" as claimed in claim 135, and the features of "an input terminal that receives a chaotically modulated signal", "a resistor coupled to the input terminal, wherein the resistor defines a current-voltage load line", "an oscillator circuit coupled to the input terminal through the resistor and driven by the chaotically modulated signal", "a chaotic circuit comprising an upper slope circuit that implements a first current-voltage function in an upper quadrant of a current-voltage response plane and a lower slope circuit that implements a second current-voltage function in a lower quadrant of the current-voltage response plane, wherein the first and second current-voltage functions have a positive slope but are offset by a voltage difference and respectively intersect the current-voltage load line in the upper and lower quadrants of the current-voltage response plane", "a synchronizing circuit, coupled to the oscillator circuit and the chaotic circuit, wherein the synchronizing circuit detects differences between the chaotically modulated signal and signals respectively present at the upper and lower slope circuits", "a detector coupled to the synchronizing circuit which recovers an information signal on the basis of the differences" as claimed in claim 137. Moreover, the Office Action has not provided teachings that suggest the above features.

53. The Office Action fails to show a correspondence to any element of the rejected claims in Group 53 with any of the cited references

Group 53 contains claims 148, 149, 150, and 151, in which claims 149, 150, and 151 depend from claim 148. As previously discussed with the claims of Group 4, the Office Action

merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 148, 149, 150, and 151, by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "buffering an output of the chaotic transmitting circuit to isolate the chaotic transmitting circuit from the communications channel", "removing a direct current voltage component from the buffered output obtained in step (1)", and "matching the amplitude and impedance of the signal obtained from step (2) to the communications channel" as claimed in claim 148. Moreover, the Office Action has not provided teachings that suggest the above features.

54. The Office Action fails to show a correspondence to any element of the rejected claims in Group 54 with any of the cited references

Group 54 contains claims 152, 153, 154, and 155, in which claims 153, 154, and 153 depend from claim 152. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 152, 153, 154, and 155 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "an isolation circuit that buffers an output of the chaotic transmitting circuit from the communications channel", "a direct current power supply coupled to the isolation circuit through a resistor, wherein the direct current power supply subtracts a direct current voltage from the output of the isolation circuit", "an attenuator circuit, coupled to the direct current power supply, wherein the attenuator circuit attenuates a signal present at the direct current power supply prior to being introduced into the communications channel" as claimed in claim 152. Moreover, the Office Action has not provided teachings that suggest the above features.

55. The Office Action fails to show a correspondence to any element of the rejected claims in Group 55 with any of the cited references

Group 55 contains claims 156, 157, 158, and 159, in which claim 157 depends from claim 156 and claim 159 depends from claim 158. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 156, 157, 158, and 159 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art

that teaches the features of "buffering a modulated chaotic signal received from the communications channel to isolate the chaotic receiving circuit from the communications channel", "amplifying the buffered signal", and "adding a direct current component to the amplified buffered signal obtained in step (2), wherein the direct current component corresponds to a direct current component subtracted at a corresponding transmitter" as claimed in claim 156, and the features of "a buffering circuit that buffers a modulated chaotic signal received from the communications channel to isolate the chaotic receiving circuit from the communications channel", "an amplifier coupled to the buffering circuit that amplifies an output of the buffering circuit", and "a direct current voltage offset circuit coupled to the amplifier, wherein the direct current voltage offset circuit adds a direct current component to the amplified buffered signal, wherein the direct current component corresponds to a direct current component subtracted at a corresponding transmitter" as claimed in claim 158. Moreover, the Office Action has not provided teachings that suggest the above features.

56. The Office Action fails to show a correspondence to any element of the rejected claims in Group 56 with any of the cited references

Group 56 contains claim 97. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 97 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "continuously varying the non-reactive resistive value over a chaotic operating region in accordance with the information signal" as claimed in claim 97. Moreover, the Office Action has not provided teachings that suggest the above features.

57. The Office Action fails to show a correspondence to any element of the rejected claims in Group 57 with any of the cited references

Group 57 contains claim 113. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 113 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "using a digitally implemented nonlinear circuit having a current-voltage characteristic that satisfies the

equation I = $-aV-bV^3$, where a and b are constants" as claimed in claim 113. Moreover, the Office Action has not provided teachings that suggest the above features.

58. The Office Action fails to show a correspondence to any element of the rejected claims in Group 58 with any of the cited references

Group 58 contains claims 125 and 130, in which claim 130 depends form claim 125. As previously discussed with the claims of Group 4, the Office Action merely alludes to all of the features of claims 4-159 without further explanation. Thus, the Office Action fails to show anticipation of claims 125 and 130 by Pinkney, Chua, Cuomo, and Tresser. For example, the Office Action fails to show prior art that teaches the features of "using a circuit that exhibits a linear slope in one quadrant of the current-voltage characteristic curve" and "changing the linear slope in the one quadrant" as claimed in claim 125. Moreover, the Office Action has not provided teachings that suggest the above features.

C. Applicant's Admission of Prior Art does not disclose or render obvious what is claimed

1. All claim limitations must be taught or suggested

The Office Action cites the Applicant's teaching in the specification (page 1 and page 2, lines 1-5) and further cites Figures 1 a-d, 2b, and 6 a-b of the present patent application. However, in order to establish *prima facie* obviousness, all the claim limitations must be taught or suggested in the prior art. The Office Action fails to show how each claim limitation of each claim is taught or suggested by the alleged Applicant's Admission of Prior Art. For example, the alleged AAPA does not show or suggest the features of "generating a chaotic carrier signal that causes a voltage to oscillate chaotically about a first equilibrium point in a current-voltage phase space of a circuit that exhibits a current-voltage characteristic curve on which the first equilibrium point falls" and "changing, in response to an information signal, a non-reactive

resistive value in the circuit and thereby causing the first equilibrium point to shift to a shifted first equilibrium point in the current-voltage phase space".

2. <u>No suggestion of combining Applicants Admission of Prior Art with other teachings</u>

As discussed above, the alleged Applicants Admission of Prior Art by itself does not teach or suggest all of the features of any claim in any claim grouping as discussed above. Moreover, the Office Action does not provide other teachings that can be combined with the alleged Applicant's Admission of Prior Art to suggest each feature of any rejected claim.

D. <u>All claims comply with the enablement requirement</u>

1. <u>Detailed description enables any person skilled in the pertinent art or science to make and use the invention without involving extensive experimentation</u>

The Office Action rejects claims 36-44, 54-109, and 111-159 as failing to comply with the enablement requirement. In accordance with MPEP §608.01(g), the "detailed description, required by CFR 1.71, MPEP §608.01, must be in such particularity as to enable any person skilled in the pertinent art or science to make and use the invention without involving extensive experimentation." The *Detailed Description* (pp. 20-91) of the present application complies with this requirement. The specification from page 36, line 1 to page 90, line 25 describes "Second-Generation Embodiments and Techniques" and supports the enablement requirement for claims 36-44, 54-109, and 111-159. As an example, claim 36 claims:

A nonlinear circuit element for use in a chaotic transmitter, comprising:

a first pair of diodes coupled in series and biased in a forward direction with respect to first and second circuit terminals;

a second pair of diodes coupled in series and biased in a reverse direction with respect to the first and second circuit terminals;

a first resistor coupled between the first pair of diodes and one of the circuit terminals;

a second resistor coupled between the second pair of diodes and one of the circuit terminals; and

an op amp coupled between the first and second circuit terminals through a resistive network;

wherein the first resistor, the second resistor, and the resistive network have values selected to bias the nonlinear circuit element such that it exhibits a piecewise linear current-voltage characteristic across the first and second terminals.

Claim 36 is supported, for example, by the Detailed Description from page 42, lines 14-21 and by Figure 6C. As shown in Figure 6C, one pair of diodes corresponds to diodes 681 and 682, another pair of diodes corresponds to diodes 683 and 684, one of the resistors corresponds to resistor 686, another resistor corresponds to resistor 685, and the op amp corresponds to operation amplifier 689. Additionally, the Detailed Description of the present application enables one skilled in the art to make and use the invention as claimed in claims 37-44, 54-109, and 111-159.

For example, as claimed in claim 57, Figures 18A-18C and the associated description (page 62, line 1 to page 63, line 29) disclose "a chaotic transmitter that receives a first information signal and generates in response thereto a first chaotic trajectory shifted signal modulated in accordance with the first information signal" (corresponding to chaotic transmitters 1801A, 1807A, and 1813A), "a chaotic receiver that receives a second chaotic trajectory shifted signal modulated in accordance with a second information signal and generates in response thereto a demodulated version of the second chaotic trajectory shifted signal" (corresponding to receivers 1801B, 1807B, and 1813B), and "an interface circuit that couples the chaotic

transmitter and chaotic receiver to a radio-frequency telephone circuit, wherein the radio-frequency telephone circuit communicates with a ground-based telephone network through one or more radio frequency transmission stations" (corresponding to interfaces 1803, 1809, and 1814).

As another example, Figure 31 and the associated description (page 68, line 17 to page 69, line 23) disclose the elements of claim 152 that include "an isolation circuit that buffers an output of the chaotic transmitting circuit from the communications channel" (corresponding to amplifier 2300), "a direct current power supply coupled to the isolation circuit through a resistor, wherein the direct current power supply subtracts a direct current voltage from the output of the isolation circuit" (corresponding to 2230), and "an attenuator circuit, coupled to the direct current power supply, wherein the attenuator circuit attenuates a signal present at the direct current power supply prior to being introduced into the communications channel" (corresponding to attenuator subsection 2480).

The above examples demonstrate that the specification complies with the enablement requirement.

E. All claims particularly point out and distinctly claim the subject matter with applicant regards as the invention

1. The language of claims is clear and specific as to what is the scope of the invention

Claims 36-44, 54-109, and 111-159 are rejected by the Office Action under 35 USC §112, second paragraph, as being indefinite for failing to particularly point and distinctly claim the subject matter which applicant regards as the invention. The Office Action states that the Examiner has difficulty relating the language of claims 25-159 to page 1, line 19 through page 2,

line 11 of the specification, which states that "the present inventors have discovered a technique for modulating the transmitting signal in a manner that results in much faster signal stability, thus reducing the amount of time required to synchronize the receiver and increasing the modulation bandwidth dramatically." Claims 36-44, 54-109, and 111-159 do particularly point and distinctly claim the subject matter which applicants regard as the invention. Even though the Examiner expresses difficulty relating the language of claims 25-159 to the specification, the language of claims 36-44, 54-109, and 111-159 is clear and specific as to what is being claimed as the invention. For example, the language of independent claims 36, 38, 41, 42, 44, 54, 55, 56, 57, 67, 75, 79, 83, 85, 96, 103, 107, 111, 116, 123, 135, 137, 144, 147, 148, 152, 156, and 158 particularly point out and distinctly claim the subject matter which the applicant regards as his invention.

2. The Office Action does not provide any specific correspondence of indefiniteness in the rejected claims

The Office Action provides only a general allegation that claims 36-44, 54-109, and 111-159 are indefinite. The Office Action fails to provide any specificity of indefiniteness in the rejected claims. Consequently, the rejections of claims 25-159 under 35 USC §112, second paragraph, is improper.

CONCLUSION

For all of the foregoing reasons, Appellant respectfully submits that the final rejection of claims 1-159 is improper and should be reversed.

Respectfully submitted,

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APPENDIX A

CLAIMS INVOLVED IN THE APPEAL

1. A method of transmitting information, comprising the steps of:

(1) generating a chaotic carrier signal that causes a voltage to oscillate chaotically about a first equilibrium point in a current-voltage phase space of a circuit that exhibits a current-voltage characteristic curve on which the first equilibrium point falls; and

(2) changing, in response to an information signal, a non-reactive resistive value in the circuit and thereby causing the first equilibrium point to shift to a shifted first equilibrium point in the current-voltage phase space.

2. The method of claim 1, wherein step (1) comprises the step of generating a chaotic carrier signal that oscillates about two equilibrium points in the current-voltage phase space, and wherein step (2) comprises the step of causing both equilibrium points to shift in the current-voltage phase space.

3. The method of claim 1, wherein the circuit exhibits a piecewise-linear current-voltage characteristic comprising three linear segments, two of the linear segments having a first slope in the phase space and the third linear segment having a second slope in the phase space; and wherein step (2) comprises the step of changing either the first slope or the second slope but not both slopes in response to the information signal.

4. The method of claim 1, wherein the circuit exhibits a piecewise-linear current-voltage characteristic comprising three linear segments, two of the linear segments having a first slope in the phase space and the third linear segment having a second slope in the phase space; and wherein step (2) comprises the step of changing both the first slope and the second slope in response to the information signal.

5. The method of claim 1, wherein step (2) comprises the step of switching a non-reactive resistive element in the circuit which changes a slope of the current-voltage characteristic curve for the circuit element.

6. The method of claim 5, wherein step (2) comprises the step of switching a resistive element in a Kennedy diode circuit.

7. The method of claim 5, wherein step (2) comprises the step of switching a resistive element in a Caltech diode circuit.

8. The method of claim 5, wherein step (2) comprises the step of switching a resistive element in an SAIC diode circuit.

9. The method of claim 1, wherein step (2) comprises the step of shorting at least two diodes arranged in opposite polarity.

10. The method of claim 1, further comprising the steps of:

(3) transmitting a signal resulting from the changed non-reactive resistive value through a communication channel;

(4) receiving the signal transmitted in step (3) in a receiver tuned to synchronize with the chaotic carrier signal generated in step (1); and

(5) providing a demodulated output containing the information signal by detecting periods of synchronization and non-synchronization with the received signal.

11. The method of claim 10, wherein:

step (3) comprises the step of transmitting a single-scroll attractor chaotic signal;

step (4) comprises the step of receiving the single-scroll attractor chaotic signal transmitted in step (3); and

step (5) comprises the step of detecting periods of synchronization and non-synchronization with the single-scroll attractor chaotic signal.

12. The method of claim 10, wherein:

step (3) comprises the step of transmitting a double-scroll attractor chaotic signal;

step (4) comprises the step of receiving the double-scroll attractor chaotic signal transmitted in step (3); and

step (5) comprises the step of detecting periods of synchronization and non-synchronization with the double-scroll attractor chaotic signal.

13. The method of claim 10, wherein:

step (3) comprises the step of transmitting a triple-scroll attractor chaotic signal;

step (4) comprises the step of receiving the triple scroll attractor chaotic transmitted in step (3); and

step (5) comprises the step of detecting periods of synchronization and non-synchronization with the triple-scroll attractor chaotic signal.

14. The method of claim 1, wherein step (2) comprises the step of changing a breakpoint voltage of a piecewise linear response curve of the circuit.

15. A chaotic transmitting circuit, comprising:

an oscillator circuit;

a resistor coupled to the oscillator circuit;

a chaotic circuit, coupled to the oscillator circuit through the resistor, wherein the chaotic circuit exhibits a current-voltage characteristic shape having a slope that intersects a load line defined by the resistor and provides an equilibrium point about which a voltage oscillates chaotically; and

means for changing the slope exhibited by the chaotic circuit in accordance with an information signal.

16. The chaotic transmitting circuit according to claim 15, wherein the oscillator circuit comprises an inductance and a first capacitance;

wherein the chaotic circuit comprises a second capacitance; and

wherein the values of the first capacitance, the second capacitance, the inductance, and the resistance are selected so as to cause the chaotic transmitting circuit to oscillate in a single-scroll attractor mode.

17. The chaotic transmitting circuit according to claim 15,

wherein the oscillator circuit comprises an inductance and a first capacitance;

wherein the chaotic circuit comprises a second capacitance; and

wherein the values of the first capacitance, the second capacitance, the inductance, and the resistance are selected so as to cause the chaotic transmitting circuit to oscillate in a double-scroll attractor mode.

18. The chaotic transmitting circuit according to claim 15, wherein the means for changing comprises means for switching a plurality of resistive values.

19. The chaotic transmitting circuit according to claim 18, wherein the means for switching shifts a voltage breakpoint on the current-voltage characteristic shape exhibited by the chaotic circuit.

20. The chaotic transmitting circuit according to claim 18, wherein the means for switching shifts a slope of a piecewise linear current-voltage characteristic shape exhibited by the chaotic circuit.

21. The chaotic transmitting circuit according to claim 18, wherein the means for switching shifts two slopes of the current-voltage characteristic shape exhibited by the chaotic circuit.

22. The chaotic transmitting circuit according to claim 15, wherein the chaotic circuit comprises circuit elements having values selected so as to cause the chaotic transmitting circuit to oscillate about a single-scroll attractor.

23. The chaotic transmitting circuit according to claim 22, wherein the means for switching shifts an equilibrium point of the single-scroll attractor among at least three different positions on the current-voltage characteristic shape, each position corresponding to a different information symbol contained in the information signal.

24. A system comprising a chaotic transmitting circuit according to claim 15 and further comprising a chaotic receiving circuit comprising circuit components matched to synchronize with the chaotic transmitting circuit.

25. A chaotic transmitting circuit, comprising:

an oscillator circuit;

a resistor coupled to the oscillator circuit;

a chaotic circuit coupled to the oscillator circuit through the resistor, wherein the chaotic circuit exhibits a current-voltage characteristic shape having a slope that intersects a load line defined by the resistor and provides an equilibrium point about which a voltage oscillates chaotically; and

a switch coupled to the chaotic circuit, wherein the switch changes a nonreactive resistive value in the chaotic circuit in accordance with an information signal and thereby causes the first equilibrium point to shift to a shifted first equilibrium point.

26. The chaotic transmitting circuit of claim 25, wherein the chaotic circuit comprises a diode circuit that exhibits a negative piecewise linear resistance.

27. The chaotic transmitting circuit of claim 25, wherein the chaotic circuit comprises:

a first op amp coupled across the oscillator circuit through the resistor, wherein the first op amp is further coupled to a first group of three resistors, a first of which is coupled between an output of the first op amp and a positive input terminal thereof; a second of which is coupled between the output of the first op amp and a negative input terminal thereof; and a third of which is coupled between the negative input terminal and a ground; and

a second op amp coupled across the oscillator circuit through the resistor, wherein the second op amp is further coupled to a second group of three resistors, a first of which is coupled between an output of the second op amp and a positive input terminal thereof; a second of which is coupled between the output of the second op amp and a negative input terminal thereof; and a third of which is coupled between the negative input terminal and the ground.

28. The chaotic transmitting circuit of claim 27, wherein the switch changes a non-reactive resistive value between the negative input terminal of the second op amp and the ground.

29. The chaotic transmitting circuit of claim 25, wherein the chaotic circuit element comprises:

a first diode arranged in a forward polarity across the oscillator circuit through a first resistor and coupled to a first voltage supply through a second resistor;

a second diode arranged in a reversed polarity across the oscillator circuit through a third resistor and coupled to a second voltage supply through a fourth resistor; and

an op amp coupled to a first group of three resistors, a first of which is coupled between an output of the op amp and a positive input terminal thereof; a second of which is coupled between the output of the op amp and a negative input terminal thereof; and a third of which is coupled between the negative input terminal and ground.

30. The chaotic transmitting circuit of claim 29,

wherein the switch modifies a resistive value between the negative input terminal of the op amp and ground.

31. The chaotic transmitting circuit of claim 25, wherein the chaotic circuit element comprises:

two forward biased diodes coupled across the oscillator circuit through a first resistor;

two reverse biased diodes coupled across the oscillator circuit through a second resistor; and

an op amp coupled across the oscillator circuit through a resistive feedback network.

32. The chaotic transmitting circuit of claim 25, wherein the chaotic circuit element comprises two diodes arranged in opposite polarity across the oscillator circuit through corresponding resistors, wherein the switch shorts the two diodes in response to the information signal and causes the chaotic transmitting circuit to stop oscillating in a chaotic manner.

33. The chaotic transmitting circuit of claim 25,

wherein the oscillator and chaotic circuit comprise circuit elements having values selected so as to cause the chaotic transmitting circuit to oscillate in a single-scroll attractor mode.

34. The chaotic transmitting circuit of claim 33,

wherein the oscillator circuit comprises an inductance and a first capacitance;

wherein the chaotic circuit comprises a second capacitance; and

wherein the values of the first capacitance, the second capacitance, the inductance, and the resistance are selected so as to cause the chaotic transmitting circuit to oscillate in a single-scroll attractor mode.

35. The chaotic transmitting circuit of claim 25,

wherein the oscillator and chaotic circuit comprise circuit elements having values selected so as to cause the chaotic transmitting circuit to oscillate in a double-scroll attractor mode.

36. A nonlinear circuit element for use in a chaotic transmitter, comprising:

a first pair of diodes coupled in series and biased in a forward direction with respect to first and second circuit terminals;

a second pair of diodes coupled in series and biased in a reverse direction with respect to the first and second circuit terminals;

a first resistor coupled between the first pair of diodes and one of the circuit terminals;

a second resistor coupled between the second pair of diodes and one of the circuit terminals; and

an op amp coupled between the first and second circuit terminals through a resistive network;

wherein the first resistor, the second resistor, and the resistive network have values selected to bias the nonlinear circuit element such that it exhibits a piecewise linear current-voltage characteristic across the first and second terminals.

37. The nonlinear circuit element of claim 36, further comprising:

a fourth resistor coupled to the resistive network; and

a switch that couples the fourth resistor into the resistive network, thus changing a slope of the piecewise linear current-voltage characteristic of the nonlinear circuit element in response to an information signal.

38. A communication system comprising a transmitter and a receiver, wherein the transmitter comprises

an oscillator circuit;

a resistor coupled to the oscillator circuit;

a chaotic circuit coupled to the oscillator circuit through the resistor, wherein the chaotic circuit causes a voltage to oscillate about a first equilibrium point on a current-voltage characteristic curve of the chaotic circuit element; and

a switch coupled to the chaotic circuit element, wherein the switch changes a nonreactive resistive value in the chaotic circuit in accordance with an information signal and thereby causes the first equilibrium point to shift to a shifted first equilibrium point; and wherein the receiver comprises

a second oscillator circuit;

a second resistor coupled to the second oscillator circuit;

a second chaotic circuit coupled to the second oscillator circuit through the second resistor; and

a detector coupled to the second oscillator circuit and the second chaotic circuit;

wherein the second oscillator circuit and the second chaotic circuit comprise circuit components selected such that they cause the receiver to synchronize with the transmitter when the transmitter transmits according to the first equilibrium point; and

wherein the detector detects whether the receiver is synchronized and, in response to detecting synchronization, generates a signal.

39. The system of claim 38, wherein the transmitter and the receiver each oscillate chaotically about a single-scroll attractor.

40. The system of claim 38, wherein the transmitter and the receiver each oscillate chaotically about double-scroll attractors.

41. A chaotic receiver comprising:

an input terminal for receiving a chaotically modulated signal;

an oscillating circuit coupled to the input terminal;

a chaotic circuit comprising a capacitor and a negative resistance element, wherein the chaotic circuit is coupled to the oscillating circuit through a resistor, wherein the chaotic circuit causes a voltage to oscillate about an equilibrium point corresponding to a current-voltage characteristic curve of the negative resistance element;

a synchronizing resistor coupled between the input terminal and the negative resistance element; and

a comparator, coupled across the synchronizing resistor, wherein the comparator generates an output signal when a voltage drop across the synchronizing resistor reaches a predetermined level; and

wherein the synchronizing resistor has a value that satisfies the relation $Rsync \leq (1/(2f_{LC} \times C_1))$

where f_{LC} is the fundamental frequency of the oscillator circuit, and where C_1 is the capacitance of the capacitor.

42. A chaotic receiver comprising:

an input terminal that receives a modulated chaotic signal;

an oscillator coupled to the input terminal;

a chaotic circuit comprising a capacitor and a negative resistance circuit;

a gain control amplifier coupled between the oscillator and the chaotic circuit, wherein the gain control amplifier amplifies a voltage present at the oscillator before it reaches the chaotic circuit;

a synchronizing resistor coupled between the input terminal and the chaotic circuit; and

a detection circuit, coupled to the synchronizing resistor, wherein the detection circuit detects periods of synchronization and non-synchronization between the modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization.

43. The chaotic receiver of claim 42, wherein the gain control amplifier provides an amplification of between 2.4 dB to 3 dB.

44. A chaotic communication system comprising:

a transmitter that generates a chaotic carrier signal modulated in accordance with an information signal; and

a receiving system having an input terminal that receives the chaotic carrier signal modulated by the transmitter, wherein the receiving system comprises

an oscillator subsystem coupled to the input terminal;

a gain control amplifier coupled to the output of the oscillator subsystem;

a chaotic subsystem coupled to the output of the gain control amplifier;

a synchronizing subsystem coupled to the chaotic subsystem and to the input terminal, which causes the chaotic subsystem to synchronize to the chaotic carrier signal; and

a detector coupled to the chaotic subsystem and the input terminal, wherein the detector detects periods of synchronization and non-synchronization;

wherein the gain control amplifier amplifies a signal produced by the oscillator subsystem and drives the chaotic subsystem with the amplified signal, and wherein the chaotic subsystem generates a signal that synchronizes with the modulated chaotic signal when the transmitter transmits a symbol of information.

45. A chaotic transmitter, comprising:

an oscillator;

a resistor coupled to the oscillator;

a chaotic circuit comprising a negative resistance, wherein the chaotic circuit is coupled to the oscillator circuit through the resistor;

an isolation amplifier coupled to the chaotic circuit;

a filter coupled to the output of the isolation amplifier that limits a frequency bandwidth present at the chaotic circuit; and

means for modulating a circuit element of the chaotic transmitter in accordance with an information signal.

46. The chaotic transmitter of claim 45, wherein the filter comprises a lowpass filter.

47. The chaotic transmitter of claim 45, wherein the filter comprises a bandpass filter.

48. The chaotic transmitter of claim 45, wherein the filter matches a bandwidth of the chaotic transmitter to a transmission medium.

49. The chaotic transmitter of claim 45, wherein the means for modulating comprises a switch that switches a reactive component in the oscillator, thereby changing a strange attractor trajectory generated by the transmitter.

50. The chaotic transmitter of claim 45, wherein the means for modulating comprises a switch that switches a reactive component in the chaotic circuit, thereby changing a strange attractor trajectory generated by the transmitter.

51. The chaotic transmitter of claim 45, wherein the means for modulating comprises a switch that changes a non-reactive resistive value in the chaotic circuit, thereby changing a current-voltage characteristic of the negative resistive element.

52. The chaotic transmitter of claim 51, wherein the transmitter oscillates about a single-scroll attractor.

53. The chaotic transmitter of claim 51, wherein the transmitter oscillates about a double-scroll attractor.

54. A chaotic receiver, comprising:

an input terminal that receives a modulated chaotic signal;

a first filter, coupled to the input terminal, which filters the modulated chaotic signal and produces a filtered modulated chaotic signal;

an oscillator coupled to an output of the first filter;

a chaotic circuit comprising a negative resistor, wherein the chaotic circuit is coupled to the oscillator;

a synchronizing circuit coupled between the first filter and the chaotic circuit, wherein the synchronizing circuit generates a voltage difference in response to an out-of-synchronization condition between the filtered modulated chaotic signal and the chaotic circuit;

a second filter, coupled to a first portion of the synchronizing circuit, which filters a buffered version of the filtered modulated chaotic signal;

a third filter, coupled to a second portion of the synchronizing circuit, which filters a signal generated by the chaotic circuit; and

a detection circuit, coupled to the second and third filters, wherein the detection circuit detects periods of synchronization and non-synchronization between the modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization.

55. A chaotic receiver, comprising:

an input terminal that receives a modulated chaotic signal;

a first filter, coupled to the input terminal, which filters the modulated chaotic signal and produces a filtered modulated chaotic signal;

an oscillator coupled to the input terminal;

a chaotic circuit comprising a circuit element that exhibits a nonlinear current-voltage characteristic, wherein the chaotic circuit is coupled to the oscillator;

a synchronizing circuit coupled between the first filter and the chaotic circuit, wherein the synchronizing circuit generates a voltage difference in response to an out-of-synchronization condition between the filtered modulated chaotic signal and the chaotic circuit;

a second filter, coupled to a first portion of the synchronizing circuit, which filters a buffered version of the filtered modulated chaotic signal;

a third filter, coupled to a second portion of the synchronizing circuit, which filters a signal generated by the chaotic circuit; and

a detection circuit, coupled to the second and third filters, wherein the detection circuit detects periods of synchronization and non-synchronization between the modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization.

56. A chaotic receiver, comprising:

an input terminal that receives a modulated chaotic signal;

a first filter, coupled to the input terminal, which filters the modulated chaotic signal and produces a filtered modulated chaotic signal;

an oscillating circuit coupled to the first filter;

a chaotic circuit comprising a circuit element that exhibits a nonlinear current-voltage characteristic, wherein the chaotic circuit is coupled to the oscillating circuit through a second filter;

a third filter, coupled to the output of the first filter, which further filters the output of the first filter;

a synchronizing circuit coupled between the third filter and the chaotic circuit, wherein the synchronizing circuit generates a voltage difference in response to an out-of-synchronization condition between a signal from the third filter and the chaotic circuit;

a fourth filter, coupled to a first portion of the synchronizing circuit, which filters a buffered version of the filtered modulated chaotic signal;

a fifth filter, coupled to a second portion of the synchronizing circuit, which filters a signal generated by the chaotic circuit; and

a detection circuit, coupled to the fourth and fifth filters, wherein the detection circuit detects periods of synchronization and non-synchronization between the modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization.

57. A chaotic telephone device comprising:

a chaotic transmitter that receives a first information signal and generates in response thereto a first chaotic trajectory shifted signal modulated in accordance with the first information signal;

a chaotic receiver that receives a second chaotic trajectory shifted signal modulated in accordance with a second information signal and generates in response thereto a demodulated version of the second chaotic trajectory shifted signal; and

an interface circuit that couples the chaotic transmitter and chaotic receiver to a radio-frequency telephone circuit, wherein the radio-frequency telephone circuit communicates with a ground-based telephone network through one or more radio frequency transmission stations.

58. The chaotic telephone device of claim 57, wherein the chaotic transmitter and the chaotic receiver respectively modulate and demodulate signals at baseband frequencies.

59. The chaotic telephone device of claim 57, wherein the chaotic transmitter and the chaotic receiver respectively modulate and demodulate signals at an intermediate frequency band that falls between the frequency band of the first and second information signals and a radio frequency band used by the radio-frequency telephone circuit.

60. The chaotic telephone device of claim 57, wherein the chaotic transmitter and the chaotic receiver respectively modulate and demodulate signals at a radio frequency band used by the radio-frequency telephone circuit.

61. The chaotic telephone device of claim 57, wherein the chaotic transmitter and the chaotic receiver respectively modulate and demodulate signals in a single-scroll strange attractor phase space.

62. The chaotic telephone device of claim 57, wherein the chaotic transmitter and the chaotic receiver respectively modulate and demodulate signals in a double-scroll strange attractor phase space.

63. The chaotic telephone device of claim 57, wherein the chaotic transmitter modulates using a first set of strange attractor parameters that match a set of strange attractor parameters in a corresponding receiver associated with the one or more radio frequency transmission stations; and wherein the chaotic receiver demodulates using a second set of strange attractor parameters in a corresponding transmitter associated with the one or more radio frequency transmission stations.

64. The chaotic telephone device of claim 57, wherein the chaotic receiver comprises:

an oscillator;

a chaotic circuit comprising a circuit element that exhibits a nonlinear current-voltage characteristic; and

a gain control amplifier coupled between the oscillator and the chaotic circuit, wherein the gain control amplifier amplifies a voltage present at the oscillator before it reaches the chaotic circuit.

65. The chaotic telephone device of claim 64,

wherein the chaotic receiver further comprises a synchronizing resistor coupled between an input of the chaotic receiver and the chaotic circuit; and

further comprising a detection circuit, coupled to the synchronizing resistor, wherein the detection circuit detects periods of synchronization and non-synchronization between the second modulated chaotic signal and the chaotic circuit and generates an output corresponding to periods of synchronization and non-synchronization.

66. The chaotic telephone device of claim 57, wherein the chaotic transmitter comprises:

an oscillator circuit;

a resistor coupled to the oscillator circuit;

a chaotic circuit comprising a circuit element that exhibits a nonlinear current-voltage characteristic, wherein the chaotic circuit is coupled to the oscillator circuit through the resistor;

an isolation amplifier coupled to the chaotic circuit;

a filter coupled to the output of the isolation amplifier that limits a frequency bandwidth present at the chaotic circuit; and

means for modulating a circuit element of the chaotic transmitter in accordance with the first information signal.

67. A method of communicating between a portable telephone device and a base station, comprising the steps of:

(1) generating an information signal at the portable telephone device;

(2) modulating a chaotic carrier signal with the information signal using a chaotic trajectory shifting technique;

(3) transmitting the chaotic trajectory shift-keyed signal generated in step (2) to the base station; and

(4) in the base station, demodulating the transmitted signal to recover the information signal.

68. The method of claim 67, wherein step (2) comprises the step of changing a non-reactive resistive value in a chaotic circuit element to cause a strange attractor trajectory shift.

69. The method of claim 67, wherein step (2) comprises the step of generating a chaotic carrier signal that oscillates about two equilibrium points in a current-voltage phase space, and further comprising the step of causing both equilibrium points to shift in the current-voltage phase space.

70. The method of claim 67, wherein step (2) comprises the step of using a nonlinear circuit element that exhibits a piecewise linear current-voltage characteristic comprising three linear segments, two of the segments having a first slope in the phase space and the third segment having a second slope in the phase space, and where step (2) comprises the step of changing either the first slope or the second slope but not both slopes in response to the information signal.

71. The method of claim 67, wherein step (4) comprises the step of detecting periods of synchronization and non-synchronization between the signal the received chaotic trajectory shift-keyed signal generated and a locally-generated chaotic signal using a circuit matched to a transmitter used to transmit in step (3).

72. The method of claim 67, wherein step (2) comprises the steps of:

(a) modulating at a baseband frequency level; and

(b) frequency translating the modulated baseband signal to a radio frequency band.

73. The method of claim 67, wherein step (2) comprises the steps of:

(a) modulating at an intermediate frequency band which falls between a frequency band of the information signal and a radio frequency band used by transmitting equipment; and

(b) frequency translating the modulated intermediate frequency signal to the radio frequency band of the transmitting equipment.

74. The method of claim 67, wherein step (2) comprises the steps of:

(a) modulating the information signal directly to a radio frequency band; and

(b) directly transmitting the modulated information signal in the radio frequency band.

75. A chaotic transmitter, comprising:

a first chaotic circuit that generates a first chaotic signal having a first strange attractor trajectory;

a second chaotic circuit that generates a second chaotic signal having a second strange attractor trajectory different from that of the first strange attractor trajectory;

a switch coupled to the first and second chaotic circuits, wherein the switch selects either the first chaotic signal or the second chaotic signal in response to an information signal; and

a low-pass filter coupled to the output of the switch.

76. The chaotic transmitter of claim 75, wherein the first and second chaotic circuits each generate a single-scroll strange attractor chaotic signal.

77. The chaotic transmitter of claim 75, wherein the first and second chaotic circuits each generate a double-scroll strange attractor chaotic signal.

78. The chaotic transmitter of claim 75, further comprising a summing circuit coupled between the switch and the low-pass filter, wherein the summing circuit sums the output from the switch.

79. A method of transmitting an information signal, comprising the steps of:

(1) generating a first chaotic signal comprising at least one strange attractor that oscillates about a first equilibrium point;

(2) generating a second chaotic signal comprising at least a second strange attractor that oscillates about a second equilibrium point;

(3) in response to the information signal, selecting an output of either the first chaotic signal or the second chaotic signal; and

(4) transmitting the selected output from step (3).

80. The method of claim 79, further comprising the step of filtering the output selected in step (3).

81. The method of claim 79, wherein steps (1) and (2) each comprise the step of generating a single-scroll strange attractor chaotic signal.

82. The method of claim 79, wherein steps (1) and (2) each comprise the step of generating a double-scroll strange attractor chaotic signal.

83. A chaotic receiver, comprising:

an input terminal that receives a modulated chaotic signal;

an oscillator circuit coupled to the input terminal;

a first chaotic circuit coupled to the oscillator circuit and tuned to a first strange attractor;

a second chaotic circuit coupled to the oscillator circuit and tuned to a second strange attractor; and

means for detecting a difference between the modulated chaotic signal received at the input terminal and respective signals generated by the first and second chaotic circuits.

84. The chaotic receiver of claim 83, further comprising a third chaotic circuit coupled to the oscillator circuit and tuned to a third strange attractor; wherein the means for detecting a difference further detects a difference between the modulated chaotic signal received at the input terminal and a signal generated by the third chaotic circuit.

85. A method of demodulating a signal modulated according to a chaotic trajectory shift-keying technique, comprising the steps of:

(1) receiving a modulated chaotic signal modulated according to a chaotic trajectory shift-keying technique;

(2) using the modulated chaotic signal to drive an oscillator;

(3) using the modulated chaotic signal and an output of the oscillator to drive a first chaotic circuit tuned to a first strange attractor;

(4) using the modulated chaotic signal and an output of the oscillator circuit to drive a second chaotic circuit tuned to a second strange attractor; and

(5) detecting a difference between the modulated chaotic signal and respective signals generated by the first and second chaotic circuits.

86. The method of claim 85, further comprising the step of using the modulated chaotic signal and an output of the oscillator circuit to drive a third chaotic circuit tuned to a third strange attractor, and wherein step (5) comprises the step of detecting a difference between the modulated chaotic signal and a signal generated by the third chaotic circuit.

87. The receiver of claim 83, wherein the means for detecting comprises:

a plurality of synchronizing resistors each of which generates a voltage drop in response to a difference between the modulated chaotic signal and a corresponding one of the first and second chaotic circuits;

means for buffering the plurality of synchronizing resistors and generating buffered outputs therefrom;

means for attenutating the buffered outputs; and

means for subtracting the buffered outputs to generate a detected signal.

88. The method of claim 85, wherein step (5) comprises the steps of:

(a) generating a voltage drop in response to a difference between the modulated chaotic signal and a corresponding one of the first and second chaotic circuits;

(b) buffering the plurality of synchronizing resistors and generating buffered outputs therefrom;

(c) attenuating the buffered outputs; and

(d) subtracting the buffered outputs to generate a detected signal.

89. The chaotic receiver of claim 83, further comprising means for generating an absolute value of the difference signal.

90. The method of claim 85, further comprising the step of:

(6) generating an absolute value signal from the difference detected in step (5).

91. The chaotic receiver of claim 83, wherein the means for detecting a difference comprises at least two synchronizing resistors, each respectively coupled between the oscillator and one of the first and second chaotic circuits, the chaotic receiver further comprising:

first and second subtractor circuits, each coupled across a corresponding one of the two synchronizing resistors;

a third subtractor circuit, coupled to the first and second subtractor circuits, wherein the third subtractor circuit generates a difference signal from the first and second subtractor circuits;

an absolute value circuit, coupled to the third subtractor circuit, which generates an absolute value signal from the third subtractor circuit; and

a squaring circuit that generates a squared version of the absolute value signal.

92. The method of claim 85, wherein step (5) comprises the step of generating a voltage drop in response to a difference between the modulated chaotic signal and a corresponding one of the first and second chaotic circuits, the method further comprising the steps of:

(6) generating first and second difference signals corresponding to first and second voltage drops from the first and second chaotic circuits;

(7) subtracting the first and second difference signals and generating a third difference signal therefrom;

(9) generating an absolute value signal from the third difference signal; and

(10) generating a squared version of the absolute value signal.

93. The chaotic receiver of claim 83, wherein the means for detecting a difference comprises at least two synchronizing resistors, each respectively coupled between the oscillator and one of the first and second chaotic circuits, the chaotic receiver further comprising:

first and second subtractor circuits, each coupled across a corresponding one of the two synchronizing resistors;

first and second absolute value circuits, each coupled to a corresponding one of the first and second subtractor circuits;

a third subtractor circuit, coupled to the first and second absolute value circuits, which generates a subtracted absolute value signal; and

a squaring circuit that generates a squared version of the subtracted absolute value signal.

94. The method of claim 85, wherein step (5) comprises the step of generating a voltage drop in response to a difference between the modulated chaotic signal and a

corresponding one of the first and second chaotic circuits, the method further comprising the steps of:

(6) generating first and second difference signals corresponding to first and second voltage drops from the first and second chaotic circuits;

(7) generating first and second absolute value signals from the first and second difference signals;

(8) subtracting the first and second first and second absolute value signals and generating therefrom a subtracted absolute value signal; and

(9) generating a squared version of the subtracted absolute value signal.

95. A chaotic receiver, comprising:

an input terminal that receives a modulated chaotic signal;

an oscillator coupled to the input terminal;

a first chaotic circuit coupled to the oscillator and tuned to a first strange attractor;

a second chaotic circuit coupled to the oscillator circuit and tuned to a second strange attractor; and

a detector circuit coupled to the first and second chaotic circuits, wherein the detector circuit subtracts signals present at the first and second chaotic circuits and generates an absolute value signal based on the subtracted signal.

96. A method of demodulating a signal modulated according to a trajectory shift-keying technique, comprising the steps of:

(1) receiving a modulated chaotic signal;

(2) using the modulated chaotic signal to drive an oscillator circuit;

(3) using the modulated chaotic signal and an output of the oscillator circuit to drive a first chaotic circuit comprising a first nonlinear circuit element and tuned to a first strange attractor;

(4) using the modulated chaotic signal and an output of the oscillator circuit to drive a second chaotic circuit comprising a second nonlinear circuit element and tuned to a second strange attractor; and

(5) detecting a difference between first and second signals present at the first and second chaotic circuits, respectively, by subtracting the first and second signals and generating an absolute value thereof.

97. The method of claim 1, wherein step (2) comprises the step of continuously varying the non-reactive resistive value over a chaotic operating region in accordance with the information signal.

98. The method of claim 1, wherein step (2) comprises the step of changing the non-reactive resistive value to one of a plurality of uniquely coded vectors within a chaotic operating region which, when received at a matched receiver, will generate a corresponding unique code.

99. The apparatus of claim 15, wherein the means for changing continuously varies the non-reactive resistance over a chaotic operating region in accordance with the information signal.

100. The apparatus of claim 15, wherein the means for changing sets the non-reactive resistive value to one of a plurality of uniquely coded vectors within a chaotic operating region which, when received at a matched receiver, will generate a corresponding unique code.

101. The apparatus of claim 25, wherein the switch continuously varies the non-reactive resistance over a chaotic operating region in accordance with the information signal.

102. The apparatus of claim 25, wherein the switch sets the non-reactive resistive value to one of a plurality of uniquely coded vectors within a chaotic operating region which, when received at a matched receiver, will generate a corresponding unique code.

103. A method of transmitting information, comprising the steps of:

(1) in response to receiving a time-varying N-bit code representing a unit of information, selecting a corresponding one of a plurality of 2^N transmitters each of which generates a chaotic strange attractor signal that is distinct from others in the plurality of 2^N transmitters; and

(2) transmitting through a communications channel the chaotic strange attractor signal selected in step (1).

104. The method of claim 103, wherein N is at least 2.

105. The method of claim 103, wherein N is at least 8.

106. (plus reception method, DEH/CPG) The method of claim 103, further comprising the steps of:

(3) receiving the chaotic strange attractor signal transmitted in step (2);

(4) matching the signal received in step (3) to one of a plurality of 2^N receivers each of which is matched to a corresponding one of the plurality of 2^N transmitters; and

(5) on the basis of the receiver matched in step (4), recovering the N-bit code received in step (1).

107. A method of recovering information transmitted through a communication channel, comprising the steps of:

(1) receiving a time-varying signal comprising discrete portions of each of a plurality of chaotic strange attractor signals;

(2) matching the signal received in step (1) to one of a plurality of 2^N receivers each of which is tuned to a different strange attractor signal; and

(3) on the basis of the receiver matched in step (2), generating an N-bit code.

108. The method of claim 107, wherein N is at least 2.

109. The method of claim 107, wherein N is at least 8.

110. A transmitting system capable of transmitting N bits of information, comprising:

a plurality of 2^N transmitters each of which generates a chaotic strange attractor signal that is distinct from others in the plurality of 2^N transmitters;

a switch which, in response to receiving a time-varying N-bit code representing a unit of information, selects a corresponding one of the plurality of 2^N transmitters; and

a transmission circuit that transmits the selected chaotic strange attractor signal across a transmission channel.

111. A receiving system comprising:

a receiving circuit that receives a time-varying signal comprising a plurality of discrete portions of each of a plurality of chaotic strange attractor signals;

a plurality of 2^N receivers each of which is tuned to one of a corresponding number of 2^N transmitters;

a plurality of detectors each of which detects whether a corresponding one of the plurality of 2^N receivers has received a matching signal; and

a switching circuit which, in response to one of the detectors detecting a corresponding match, generates an N-bit code representing a transmitted unit of information.

112. An information transmission system comprising a transmitting system according to claim 110 and a receiving system, wherein the receiving system comprises:

a receiving circuit that receives a time-varying signal comprising a plurality of discrete portions of each of a plurality of chaotic strange attractor signals;

a plurality of 2^N receivers each of which is tuned to one of the 2^N transmitters;

a plurality of detectors each of which detects whether a corresponding one of the plurality of 2^N receivers has received a matching signal; and

a switching circuit which, in response to one of the detectors detecting a corresponding match, generates an N-bit code representing a transmitted unit of information.

113. A method according to claim 1, wherein step (1) comprises the step of using a digitally implemented nonlinear circuit having a current-voltage characteristic that satisfies the equation $I = -aV-bV^3$, where a and b are constants.

114. The chaotic transmitting circuit of claim 15, wherein the chaotic circuit comprises a digitally implemented circuit having a current-voltage characteristic that satisfies the equation $I = -aV-bV^3$, where a and b are constants.

115. The chaotic transmitting circuit of claim 25, wherein the chaotic circuit comprises a digitally implemented circuit having a current-voltage characteristic that satisfies the equation $I = -aV-bV^3$, where a and b are constants.

116. A chaotic receiver comprising:

an input terminal that receives a modulated chaotic signal;

an oscillator circuit coupled to the input terminal and driven by the modulated chaotic signal;

a chaotic circuit comprising an upper slope circuit that implements a first current-voltage function in an upper quadrant of a current-voltage response plane and a lower slope circuit that implements a second current-voltage function in a lower quadrant of the current-voltage response plane, wherein the first and second current-voltage functions

have a different voltage offset, and wherein the upper and lower slope circuits cooperate with the oscillator circuit to generate a local chaotic signal;

a synchronizing circuit, coupled to the oscillator circuit and the chaotic circuit, wherein the synchronizing circuit detects differences between the modulated chaotic signal at the input terminal and the local chaotic signal; and

a detector coupled to the synchronizing circuit which detects periods of synchronization and non-synchronization.

117. The chaotic receiver of claim 116, wherein the upper and lower slope circuits each comprise a voltage source coupled to a negative resistance circuit.

118. The chaotic receiver of claim 116, further comprising:

a first analog-to-digital converter coupled to the oscillator circuit;

a second analog-to-digital converter coupled to the upper slope circuit; and

a third analog-to-digital converter coupled to the lower slope circuit;

wherein the detector detects periods of synchronization and non-synchronization with respect to the output of each of the first, second, and third analog-to-digital converters.

119. The chaotic receiver of claim 116, further comprising:

a first filter, coupled between the input terminal and the oscillator circuit, wherein the first filter filters the modulated chaotic signal and produces a filtered modulated chaotic signal;

a second filter, coupled to a first portion of the synchronizing circuit, wherein the second filter filters a buffered version of the filtered modulated chaotic signal; and

a third filter, coupled to a second portion of the synchronizing circuit, wherein the third filter filters a signal generated by the chaotic circuit; and

wherein the detector is coupled to respective outputs of the second and third filters.

120. The chaotic receiver of claim 116, further comprising:

a first filter, coupled between the input terminal and the synchronizing circuit, wherein the first filter filters the modulated chaotic signal and produces a filtered modulated chaotic signal;

a second filter, coupled to a first portion of the synchronizing circuit, wherein the second filter filters a buffered version of the filtered modulated chaotic signal; and

a third filter, coupled to a second portion of the synchronizing circuit, wherein the third filter filters a signal generated by the chaotic circuit; and

wherein the detector is coupled to respective outputs of the second and third filters.

121. The chaotic receiver of claim 116, further comprising:

a first filter, coupled between the input terminal and the oscillator circuit, wherein the first filter filters the modulated chaotic signal and produces a filtered modulated chaotic signal;

a second filter coupled between the chaotic circuit and the oscillating circuit;

a third filter, coupled to an output of the first filter, which further filters the output of the first filter;

wherein the synchronizing circuit is coupled between the third filter and the chaotic circuit, and wherein the synchronizing circuit generates a voltage difference in response to an out-of-synchronization condition between a signal from the third filter and the chaotic circuit;

a fourth filter, coupled to a first portion of the synchronizing circuit, which filters a buffered version of the filtered modulated chaotic signal; and

a fifth filter, coupled to a second portion of the synchronizing circuit, which filters a signal generated by the chaotic circuit;

wherein the detection circuit is coupled to respective outputs of the fourth and fifth filters.

122. The apparatus of claim 116, wherein the upper slope circuit satisfies the relation I = GbV + GaVbp – GbVbp; wherein the lower slope circuit satisfies the relation I = GbV – GaVbp + GbVb, where I is the current through each respective slope circuit, Gb is a first slope constant, V is the voltage across the respective slope circuit, Ga is a second slope constant, and Vbp is a breakpoint voltage.

123. A method of demodulating a chaotically modulated signal, comprising the steps of:

(1) receiving the chaotically modulated signal;

(2) applying the signal received in step (1) to an oscillator through a resistor that defines a load line;

(3) applying the signal applied to the oscillator in step (2) to first and second slope detector circuits each of which defines a linear current-voltage function that intercepts the load line in a different quadrant of a current-voltage plane;

(4) applying respective outputs of the first and second slope detector circuits to a synchronizing resistor circuit that generates voltage differences corresponding to differences between each respective slope detector circuit and the chaotically modulated signal received in step (1); and

(5) detecting an output from the synchronizing resistor circuit to provide a demodulated signal.

124. The method of claim 123, wherein step (4) comprises the step of using at least one slope detector circuit that satisfies the relation $I = GbV - GaVbp + GbVb$, where I is the current through the slope detector circuit, Gb is a first slope constant, V is the voltage across the slope detector circuit, Ga is a second slope constant, and Vbp is a breakpoint voltage.

125. The method of claim 1, wherein step (1) comprises the step of using a circuit that exhibits a linear slope in one quadrant of the current-voltage characteristic curve, and wherein step (2) comprises the step of changing the linear slope in the one quadrant.

126. The apparatus of claim 15, wherein the means for changing comprises a voltage source and a switch that shifts a slope in one quadrant of the current-voltage characteristic shape.

127. The apparatus of claim 25, wherein the switch switches a voltage source to shift to the shifted first equilibrium point.

128. The apparatus of claim 75, wherein the first chaotic circuit exhibits a first current slope that is offset to intersect a load line in an upper quadrant of a current-voltage characteristic curve; and wherein the second chaotic circuit exhibits a second current slope that is offset to intersect the load line in a lower quadrant of the current-voltage characteristic curve.

129. The method of claim 79, wherein step (1) comprises the step of generating a first chaotic signal that oscillates about a first equilibrium point in an upper quadrant of a current-voltage phase space of a chaotic circuit element, and wherein step (2) comprises the step of

generating a second chaotic signal that oscillates about a second equilibrium point in a lower quadrant of the current-voltage phase space.

130. The method of claim 125, further comprising the step of filtering an output of the circuit to limit its frequency bandwidth.

131. The apparatus of claim 126, further comprising a filter coupled to an output of the chaotic circuit that limits a frequency bandwidth thereof.

132. The apparatus of claim 127, further comprising a filter coupled to an output of the chaotic circuit that limits a frequency bandwidth thereof.

133. The chaotic receiver of claim 116, wherein the upper and lower slope circuits each implement current-voltage functions having the same positive slope.

134. The chaotic receiver of claim 133, wherein each of the upper and lower slope circuits define asymptotically stable intersection points with a negative resistive load line.

135. A method of demodulating a chaotically modulated signal, comprising the steps of:

(1) receiving the chaotically modulated signal;

(2) applying the signal received in step (1) to an oscillator through a resistor that defines a current-voltage load line;

(3) applying the signal applied to the oscillator in step (2) to a slope detector circuit that exhibits a current slope function opposite in polarity to that of the load line and which intersects the load line at an equilibrium point corresponding to an equilibrium point of a transmitter;

(4) generating a difference signal representing a difference between the chaotically modulated signal received in step (1) and the output of the slope detector circuit; and

(5) recovering an information signal on the basis of the difference signal generated in step (4).

136. The method of claim 135, wherein step (3) comprises the step of applying the signal applied to the oscillator in step (2) to a second slope detector circuit that exhibits a second current slope function opposite in polarity to that of the load line but which intersects the load line at a different equilibrium point; and wherein step (4) comprises the step of generating a

second difference signal representing a difference between the chaotically modulated signal received in step (1) and the output of the second slope detector circuit.

137. A chaotic receiving circuit, comprising:

an input terminal that receives a chaotically modulated signal;

a resistor coupled to the input terminal, wherein the resistor defines a current-voltage load line;

an oscillator circuit coupled to the input terminal through the resistor and driven by the chaotically modulated signal;

a chaotic circuit comprising an upper slope circuit that implements a first current-voltage function in an upper quadrant of a current-voltage response plane and a lower slope circuit that implements a second current-voltage function in a lower quadrant of the current-voltage response plane, wherein the first and second current-voltage functions have a positive slope but are offset by a voltage difference and respectively intersect the current-voltage load line in the upper and lower quadrants of the current-voltage response plane;

a synchronizing circuit, coupled to the oscillator circuit and the chaotic circuit, wherein the synchronizing circuit detects differences between the chaotically modulated signal and signals respectively present at the upper and lower slope circuits; and

a detector coupled to the synchronizing circuit which recovers an information signal on the basis of the differences.

138. The chaotic receiving circuit of claim 137, further comprising a plurality of upper slope detector circuits and a plurality of lower slope detector circuits, wherein each upper slope circuit and each lower slope circuit intersects the current-voltage load line at a different point, each point corresponding to a symbol of information.

139. The chaotic receiving circuit of claim 137, wherein the detector comprises a first analog-to-digital converter coupled to an output of the oscillator circuit, a second analog-to-digital converter coupled to upper slope circuit, and a third analog-to-digital converter coupled to the lower slope circuit, wherein the outputs of the first, second, and third analog-to-digital converters are used to recover the information signal.

140. The method of claim 1, wherein step (1) comprises the step of using a circuit that exhibits a positive linear slope, and wherein step (2) comprises the step of changing the positive linear slope.

141. The apparatus of claim 15, wherein the chaotic circuit exhibits a positive linear slope.

142. The apparatus of claim 25, wherein the chaotic circuit exhibits a positive linear slope.

143. The apparatus of claim 75, wherein the first chaotic circuit exhibits a first positive linear current slope that is offset to intersect a load line in an upper quadrant of a current-voltage characteristic curve; and wherein the second chaotic circuit exhibits a second positive linear current slope that is offset to intersect the load line in a lower quadrant of the current-voltage characteristic curve.

144. A method of transmitting information, comprising the steps of:

(1) generating a chaotic carrier signal characterized by a voltage that oscillates chaotically about a first equilibrium point in a current-voltage plane, wherein the first equilibrium point is defined by an intersection of a current-voltage load line having a first slope and a current-voltage slope line having a second slope opposite in polarity to that the of the first slope;

(2) in response to a time-varying information signal comprising an N-bit symbol, selecting one of a plurality of 2^N equilibrium points defined by successive intersections of a plurality of current-voltage slope lines having slopes opposite to that of the load line and that intersect the load line at different points;

(3) shifting the first equilibrium point to the one selected equilibrium point such that the chaotic carrier signal oscillates chaotically about the one selected equilibrium point; and

(4) transmitting the chaotic carrier signal shifted in step (3).

145. The method of claim 144, wherein step (3) comprises the step of changing a nonreactive circuit value in a chaotic circuit coupled to a resistor that defines the current-voltage load line.

146. The method of claim 144, further comprising the steps of:

(5) receiving the signal transmitted in step (4);

(6) determining which of the plurality of equilibrium points corresponds to the signal received in step (5); and

(7) on the basis of the determination in step (6), generating an information symbol.

147. Apparatus for transmitting a modulated chaotic signal, comprising:

a computer that generates, in response to an information signal, a digital word comprising N bits;

a digital-to-analog converter, coupled to the computer, that converts the digital word into an analog signal selected from one of 2^N possible signal levels; and

means for converting the analog signal into a chaotically oscillating signal that oscillates about a current-voltage equilibrium point defined by an intersection of a resistive load line and a current-voltage function uniquely defined by the analog signal.

148. A method of interfacing a chaotic transmitting circuit to a communications channel without using a frequency filter, comprising the steps of:

(1) buffering an output of the chaotic transmitting circuit to isolate the chaotic transmitting circuit from the communications channel;

(2) removing a direct current voltage component from the buffered output obtained in step (1); and

(3) matching the amplitude and impedance of the signal obtained from step (2) to the communications channel.

149. The method of claim 148, wherein step (2) comprises the step of using a direct current power supply and an attenuator circuit.

150. The method of claim 148, wherein step (3) comprises the step of using a balanced line driver to match the electrical characteristics of a twisted pair wire communications channel.

151. The method of claim 148, wherein step (3) comprises the step of matching the amplitude and impedance of the signal obtained from step (2) to a light emitting diode.

152. Apparatus for interfacing a chaotic transmitting circuit to a communications channel without using a frequency filter, comprising:

an isolation circuit that buffers an output of the chaotic transmitting circuit from the communications channel;

a direct current power supply coupled to the isolation circuit through a resistor, wherein the direct current power supply subtracts a direct current voltage from the output of the isolation circuit; and

an attenuator circuit, coupled to the direct current power supply, wherein the attenuator circuit attenuates a signal present at the direct current power supply prior to being introduced into the communications channel.

153. The apparatus of claim 152, wherein the communications channel comprises a cable system.

154. The apparatus of claim 152, further comprising a balanced line driver that matches the electrical characteristics of the apparatus to a dual conductor cable.

155. The apparatus of claim 152, wherein the communications channel comprises a radio frequency channel.

156. A method of interfacing a chaotic receiving circuit to a communications channel without using a frequency filter, comprising the steps of:

(1) buffering a modulated chaotic signal received from the communications channel to isolate the chaotic receiving circuit from the communications channel;

(2) amplifying the buffered signal; and

(3) adding a direct current component to the amplified buffered signal obtained in step (2), wherein the direct current component corresponds to a direct current component subtracted at a corresponding transmitter.

157. The method of claim 156, further comprising the step of, prior to step (1), passing the modulated chaotic signal through a balanced input buffer/amplifier that matches electrical characteristics of a dual conductor communications channel to the chaotic receiving circuit.

158. Apparatus for interfacing a chaotic receiving circuit to a communications channel without using a frequency filter, comprising:

a buffering circuit that buffers a modulated chaotic signal received from the communications channel to isolate the chaotic receiving circuit from the communications channel;

an amplifier coupled to the buffering circuit that amplifies an output of the buffering circuit; and

a direct current voltage offset circuit coupled to the amplifier, wherein the direct current voltage offset circuit adds a direct current component to the amplified buffered signal, wherein the direct current component corresponds to a direct current component subtracted at a corresponding transmitter.

159. The apparatus of claim 158, further comprising a differential input amplifier, coupled to the buffering circuit, wherein the differential input amplifier rejects common-mode input components and amplifies differential components.